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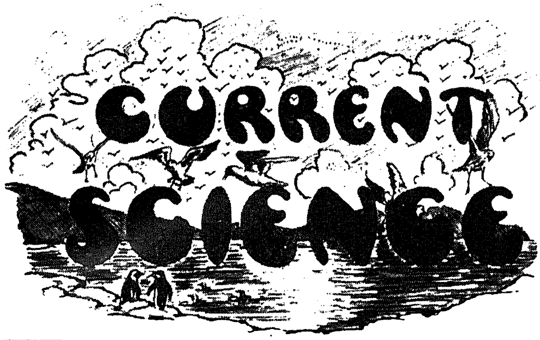


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## Ourselves.

WITH this issue, *Current Science* enters on its third year, so the present is regarded as a suitable occasion to review the progress of the past two years.

It has been generally admitted by scientific workers, both in India and abroad, that the Journal fulfils a long-felt want; that it represents the progress, at any rate, of a large section of Indian science; and that it provides a useful medium for active scientific contact between India and the rest of the world. The popularity of the Journal is evidenced by the large number of contributors and wide circle of readers both in India and elsewhere. Its publications are abstracted and reviewed by various technical Journals in different parts of the world. The original contributions, as also many of the Special Articles, are cited in literature and extracts liberally quoted. It is indeed flattering to note that some of the articles appearing in *Current Science* have been reproduced as such in a number of technical Journals.

From the scientific point of view, the most important section of the Journal is that which relates to Letters to Editor. The value of a science news Journal depends largely on prompt publication of new findings and this fact is recognised by the Editors who are endeavouring to provide all possible facilities in this direction. Letters which are received up to the 9th or 10th of each month are generally included in the issue appearing in about a fortnight from that date. Except in some occasional cases where the referee resides at some considerable distance, or is otherwise unable to deal quickly with the matter, every note is promptly scrutinised and the authors informed of the decisions of the Board as early as possible.

The technical status of a Journal is largely determined by the quality of its matter and this applies more than anything else to the nature of the announcement which figure in correspondence columns. Great care is being exercised therefore in the scrutiny of papers received for publication in this section. In this connection it may be mentioned that acting on the recommendations of their specialist referees, the Editors have on several occasions been obliged either to refuse publications or to return papers to authors for the necessary alterations.

This was always done in good faith and with proper courtesy and it is pleasing to record that most authors accepted the decisions in the right spirit.

It is largely as the result of the above that the Letters columns of *Current Science* have found favour with many of the contributors from both within India and abroad. The columns have provided space not only for announcements of new findings but also for discussion of themes of controversial character. The latter have elicited many points of much scientific interest and except in a few stray cases, have generally been marked by moderate tone and liberal outlook.

The Special Articles have always formed an important feature of the Journal. They are mostly contributions from experts in the respective lines and generally written in a style and manner calculated to interest not only other specialists in the line but also those pursuing other branches of science. The articles have generally been of the nature of reviews covering a vast field and often including a useful part of the author's own contributions to the subject. Some have also been themes with constructive suggestions relating to certain scientific departments of the Government. There have also been some others dealing with subjects of topical interest such as the Cyclone on the East coast, and the Earthquake in Bihar.

The leading articles have generally dealt with subjects of popular as well as specialised technical interest. They have covered a wide range of themes from molasses to birth-control and from the several letters we have received it has to be inferred that they are being read with considerable interest by a large section of readers. The articles have not been mere scientific discussions: in many cases, they have also included constructive suggestions some of which have already been adopted while others are being seriously considered by the Governments or organisations concerned. Particular mention may be made of the articles relating to Marine Fisheries, Protection of Game and an Academy of Sciences for India—all of which have excited considerable interest both in India and abroad.

In January of every year the Journal issues a special Supplement relating to the meeting of the Indian Science Congress held during that month. The Supplement includes a leading article, the Presidential Address *in extenso* and abstracts of the different Sectional Addresses. Some space is also devoted to summaries of public lectures and technical symposia held under the auspices of the Congress. Proceedings of annual meetings of different learned Societies which take place during the Congress Week are also briefly narrated. In addition to the above, the second volume of the Journal also includes a special Review Supplement relating to a wide range of publications issued during that year. It is hoped that with more encouragement and better co-operation, it will be possible during succeeding years to issue more supplements, dealing with a wide range of subjects.

The Research Notes include abstracts of a number of outstanding contributions in different branches of science. In addition to noticing subjects of purely scientific interest, special effort is also made to include findings of practical importance. The available space being rather restricted, it is not possible to include notes relating to all branches of science in any single issue of the Journal, but the matter is being so distributed that most of the subjects are covered in the course of a few months.

The section of Science News is devoted to a variety of subjects such as certain types of technical matter which for certain reasons cannot be included under other heads, scientific items of general interest, university and educational intelligence, appointments, scholarships for higher studies and such like. This section has been popular with a large section of readers and it is hoped that it will be possible to make it still more interesting and useful in the later issues.

Some space is allotted to subjects of industrial interest but it has not so far been possible to find themes of such general interest as would appeal to most of our readers. It is hoped, however, with increasing interest in the industrial development of the country it would be possible to allot more space to this section.

The advertisements relating to scientific equipment or technical literature are quite select in their character. They are sponsored by firms of very high standing and we are proud to include them among our clients. Owing to the fairly long interval that lapses between the issues of the Journal, we have so far been able to attract only

a few advertisements relating to higher appointments in science, but it is hoped that it will be possible to include more in the present and the later volumes. In addition to this it is also proposed to provide some additional space under the section of Science News or elsewhere for brief notes relating to some of the higher appointments for which applications are invited during the month in which the Journal appears.

Taken on the whole, the past two years have witnessed the consolidation of the position of the Journal both in India and abroad, accompanied by steady improvement in various directions. Any little success that has been achieved is largely due to the active support and co-operation of a number of scientific workers in India and abroad. To them as also to our other friends we are thankful for the good start which the Journal has made and the bright outlook for the future.

Even in days of general affluence, scientific journalism was rarely ever a financial success. It need hardly be wondered therefore that in these days of stringency, *Current Science* can hardly hope to run on the comparatively small income derived from subscriptions alone. Fortunately for the venture, a few Universities and scientific institutions have generously come to our assistance. Particular mention may be made of the liberal donations from the Universities of Madras, Mysore, Hyderabad and Nagpur, as also the Indian Science Congress. The Council of the Indian Institute of Science have not only given substantial annual grants but have also provided the Journal with room for its office and other facilities. But for these and other friends who have liberally donated in their private capacities, the Journal would not have been the success that it is to-day.

Even at the time of our writing, the financial position of the Journal is not so strong as one would wish it to be. The income is just about sufficient to meet the liabilities, so there is hardly any margin for fresh developments. It is earnestly hoped therefore that more Universities, scientific institutions and private donors would come forward and help the promoters in their venture. *Current Science* is a national institution standing for the progress of science in India and it is the duty of every one interested in the welfare of the country to rally round and render all possible assistance to make the Journal an international success.

## The Great Indian Fin Whale (*Balænoptera Indica*) stranded at Bombay.

On 7th May a large specimen of the Great Indian Fin Whale was washed ashore at the Colaba Reclamation, Bombay. The specimen had evidently been long dead as it was thrown up in a highly decomposed condition. Being an unusual sight and considered a sacred animal, news of the monster spread far and wide. Hundreds of people continued to visit the spot for several days till the carcass was removed. In spite of the condition of the carcass people flocked to collect the oozing blubber and portions of the meat. The condition of the animal was such that it was quite impossible to make detailed notes to amplify the meagre description of Blandford in the *Fauna British India* (*Mammalia*), p. 567. This description was based on the mandibular rami, a rib, the right radius and 5 vertebræ preserved in the Indian Museum, Calcutta. Nothing is known of the external characters of this whale.

Though the *Times of India* reported this specimen to be 52 ft. in length, the figure is much under-estimated, considering the actual length of the mandibular rami. Each mandible taped approximately 20 ft. 4 in. over the outer curve and 16 ft. in straight measurement. Working on this data it is estimated that this whale could not have been much under 70 ft. when in the flesh, perhaps even a little longer.

There are several records of the stranding of this species along the west coast of India. A specimen measuring 63 ft. was washed ashore at Bassein, north of Bombay, in 1906.[1] Another, 70 ft. in length, was reported from Viziadrug, near Ratnagiri. In 1912 a specimen 61 ft. was stranded at Ratnagiri. Prater[2] gave some measurements and a photograph of the small Great Indian Fin Whale 41 ft. in length, which was washed up at Ratnagiri in 1914. There are a few records of the stranding of this species along our coast. In all cases the carcasses were too decomposed to add much to the existing description.

McCANN.

[1] *J. Bombay Nat. Hist. Soc.*, 1906, **17**, 533.
[2] *Ibid.*, 1914, **23**, 576.

# Hydraulic Laboratories of the West, Their Technique and Equipments.

By Dr. N. K. Bose,
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IN the West hydraulic experiments have come to be recognised as the first essentials before a hydraulic construction of any magnitude is undertaken. Though the laws concerning hydraulic similitude are still in the making it is admitted on all hands that hydraulic model experiments conducted on proper lines can show up all the intricacies of movement inside the water medium which our present knowledge of mathematics and hydrodynamics cannot follow. It is therefore one of those cases that crop up very often in modern sciences where experiments come to the help of mathematics to establish a theory. This intimate interplay of theory and practice makes Hydraulics one of the most difficult of sciences. A number of careful experiments were conducted in the 19th century on various hydraulic problems. "Of these experimentalists perhaps Mariotte, Bernoulli and D'Alembert with Poiseuille, Darcy and Bazin in France, Rankine, Froude, Reynolds and James Thomson in England, Eytelwein, Weisbach and Hagen in Germany, Venturi in Italy with Francis and Hamilton Smith in America are most worthy of note.

"In spite, however, of all the work which has been so ably accomplished by these and other observers, Hydraulics cannot yet be classed as an exact science. The laws governing many of its phenomena are still imperfectly understood."[1] It had continued like this for some time till it was recognised that these laws had very serious limitations. Hydraulic structures based on Bligh's theory were found to be very unsafe[2], canals designed on Kennedy's theory very seldom ran smoothly.[3] Hydraulics was at this stage when it was felt that something more than empirical laws was necessary if we wanted to control nature—a deeper insight into the workings of nature. A scientific and not only practical handling of the problems was felt imperative. It was felt that these problems must be tackled more scientifically always with an eye to their practical applications. This new recognition has given rise to three distinct classes of Hydraulic Laboratories. The first are the purely scientific laboratories generally called Hydrodynamic Laboratories. These extend their fields of activities not only to Hydraulics but to Aeronautics and Meteorology as well. The second class are purely practical and are strictly confined to the practical solution of definite problems. The third class are a combination of the above two and have the most difficult and most useful career before them. I shall take a typical case from each of these classes and show their workings.

Of the first class the best that I have visited is that of Prof. L. Prandtl of the University of Göttingen. It is called Der Kaiser Wilhelm Institute fur Stromungsforschung—the Research Institute for Fluid Movement. It has got four laboratories—one for hydrodynamical research, another for aerodynamics, third for turbine and the fourth for research by students. As I was concerned mostly with the first laboratory I shall describe briefly some of the experiments that were being carried on there at the time of my visit. The experiments that have made Prandtl's Laboratory famous throughout the scientific and engineering world are varied. I shall concentrate mainly on Turbulence that has direct bearings on Irrigation Problems. Prof. Prandtl's laws of turbulent flow[4] in pipes have shown how even for high Reynolds' number the friction loss in pipes is dependent on this number. At present experiments are in progress that will show where this influence ceases. This fact that even in the turbulent region, unless the Reynolds' number is very high, friction loss due to turbulence depends on this number, is very important for model experiments and limits very seriously the dimensions of the model. It is well to point out here that the loss of energy due to turbulent friction is much more, sometimes even a thousand times more than that due to viscous friction. Prandtl's theoretical

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[1] *Hydraulics and Its Application*, Prof. Gibson.

[2] E. Mckenzie Taylor, *Curr. Sci.*, 1934, **2**, 367.

[3] G. Lacey, "Uniform flow in alluvial rivers and canals," *Proc. Inst. Civil Engineers*, Session 1933-34, **23**.

[4] "Neue Ergebnisse der Turbulenz-forschung," Prof. L. Prandtl. *Zeitschrift des Vereines Deutscher Inginieur*, 1933.

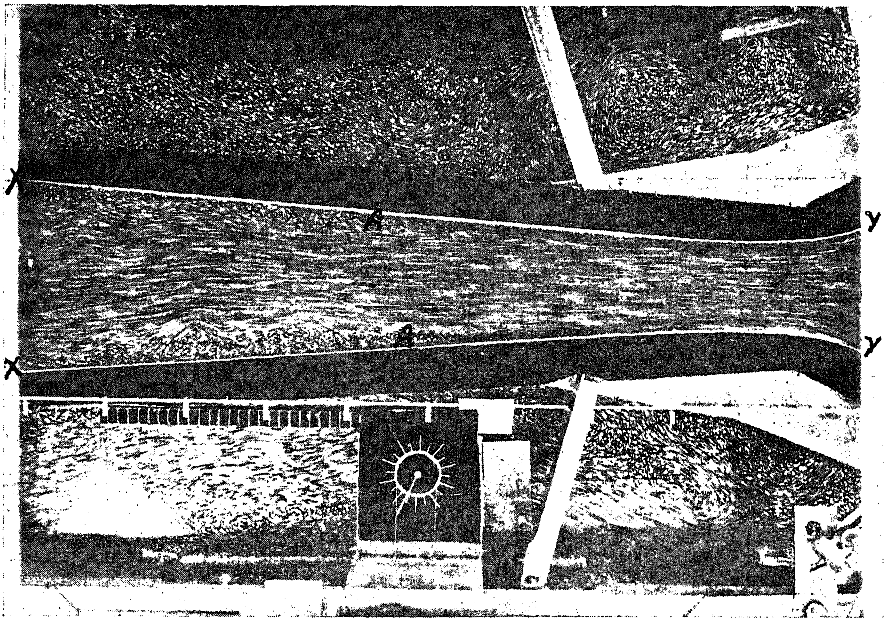


**Fig. 1.**

Refers to a series of experiments mentioned on page 4 in Prof. Prandtl's Laboratory at Göttingen.

Illustrates beautifully at A and A the side scour on the downstream end of an apron—XAY and XAY are the sides of the apron. The clock work with the scale enables the velocity of flow to be recorded automatically.

deductions from these experiments and G. I. Taylor's[5] mathematical analysis of Townsend and Fage's experiments have to a certain extent cleared our ideas about turbulence and will in future help us to tackle the problem of silt-control in rivers and canals. There is another class of problems that are being tackled in this laboratory that have direct bearing on some of our irrigation problems. It is well known that when water flows along a fixed surface there is a retarded layer of water between the fixed surface and the free fluid. This retarded layer called the boundary layer under certain circumstances leaves the fixed surface and generates a series of vortices between the fixed surface and the free fluid. These vortices generally scour away the fixed surface. It will be seen that we have the same phenomenon occurring at the downstream end of the wing walls of a fall or a weir. This problem is being attacked theoretically and experimentally in his laboratory.

[5] "The Transport of Vorticity and Heat through fluids in Turbulent Motion," Prof. G. I. Taylor. *Proceedings of the Royal Society*, Series A, 1932, **135**.

Of the second class the best I think is at Carlsruhe under the direction of Prof. Rehbock. Though Rehbock started his hydraulic research with his well-known formula for the discharge over a rectangular weir, of late years he has been mostly busy with experiments on river control and harbour reconstruction. His work on Zudar See was directed principally with an eye to immediate application; and in his present work on the Rhine, all his energy has been directed to the practical solution of the problem. His conception of 3 or 4 variables and treating them as independent has been more than justified by success. In dealing with river problems or scour and silting problems he is not at all conventional but strikes out a path which is novel and very often not approved of by the leading hydraulicians. I shall describe in detail only one of the various experiments that are in progress in his laboratory. The general principles of river experiments are as follows: When it is decided to do model experiments on a stretch of a river a long stretch of the river is taken and 2 or 3 different models with different scale ratios are constructed, say 200: 1, 160: 1, 150: 1, the

length ratio and the depth ratio are the same. Having thus fixed 'n' the discharge is consequently fixed. The river is then built with its levée that has remained stationary for a considerable length of time. The bed of the model which has a different slope steeper than that of the river is filled uniformly with brown-coal—very light chips of coal about 1 to 1·5 mm. in size and density about 1·4—to a certain depth. A certain discharge is allowed to pass over the model for different lengths of time and the contours traced out by the water are photographed by a camera that travels on two rails at a height of about 2 to 3 m. above the model, the rail is kept parallel to the water surface so that photographs of the same size are obtained every time. These contours are then obtained for different discharges and then compared to the actual contours of the river bed; by this means a time factor for each experiment is obtained which is different for different rivers. This time factor depends on the slope and the quality of the silt used. For a stretch of the Rhine they have found that for the scale ratio 160:1, the time factor 61 is nearly correct, so that a change that took 2 years in the Rhine to take place will require less than one day in the model. This makes his experiment quick and has been more than justified in practice.

Of the third class of laboratories I think that of Prof. Meyer Peters at Zurich is by far the best. Though built only three years

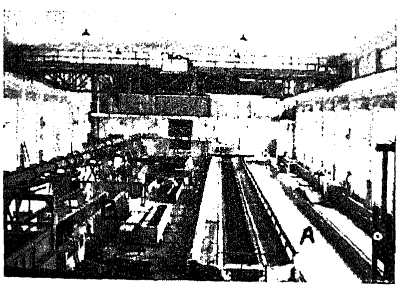


**Fig. 2.**

Shows a corner of Prof. Meyer Peters' Laboratory.

A marks the big flume referred to on page 6. B marks the moveable inlet arrangement referred to on page 7.

ago one could easily see that it has got a most useful career before it. In equipment and arrangement I think it is the best and being the youngest it has profited by all the experiences of its predecessors. A series of experiments that are being carried on there will show clearly how Prof. Meyer Peters is trying to combine theoretical and practical aspects of a problem in these experiments. I found his assistant Einstein, son of the world-famous scientist, busy in finding the model rules for experiments with silt. This is in connection with some Rhine experiments in which it is proposed to investigate the silt carrying capacity of the Rhine. At present there are two similar experiments on the same line—one with pebbles about the size of 3 to 4 cm. and the other with ·5 to ·8 mm. The central idea in these experiments is the following:—In the experiments on the bigger scale which is supposed to be the prototype, of the 4 variables $Q$ the quantity of water, $q$ the quantity of pebbles introduced per second, $i$ the slope and $t$ the depth of water, only the quantity $q$ is variable, all the other quantities are kept constant. It is found that for each $Q$ and $q$, the slope $i$ and the depth $t$ adjust themselves, so that by changing $q$, the slope and depths can be varied. Corresponding to this big scale experiment a model experiment on a small scale about 20:1, is being carried on in a small flume, so that for each $Q$ there corresponds a $Q'$, for $i$ a $i'$, $t$ a $t'$ and $q$ a $q'$. This is being done in the two flumes simultaneously with corresponding $Q$ and $Q'$. It will be seen that of these two experiments that on the big scale one is directed to a practical purpose whereas the small scale one serves the purpose of establishing the theory of model experiment for silt.

The equipments of these laboratories have been more or less standardised in the course of the last few decades. With the exception of a few arrangements that might be required to meet the special needs of any particular set of experiments or sometimes the special bias of the man in charge, the hydraulic laboratories are coming to be built more or less on the same lines. There are a few well-recognised principles :—

1. There should be as few fixtures in the hall as possible. With the exception of the High Level Reservoir no arrangement is fixed in the laboratory—even this exception Prof. Seifert of the Prussian Government Laboratory at Charlottenburg thinks unnecessary. This is found to add considerably to the flexibility of a laboratory and to its capacity to accommodate different experiments specially on river-control at the same time. The latest laboratory of Prof.

Meyer Peters is built on this type and has been found to work quite satisfactorily. In his laboratory there are a number of moveable inlet arrangements provided with graduated rectangular weir. These inlets can be joined to the high-level reservoir, connections from which run all over the laboratory floor; and they can be coupled with any experiment that wants the required discharge, so that it is possible to build the model at any part of the floor of the laboratory hall.

2. The High Level Reservoir is regarded as the soul of the Laboratory. Much depends on the way this behaves. A steady supply of water is found to be the first essential of all hydraulic experiments. The type at Carlsruhe has become the model for almost all the laboratories. It has the overflow capacity of six litres per meter length of the spillway. This is found to be more than ample—sometimes we can do with less. Of course opinions differ about the most suitable height for these reservoirs. Rehbock thinks they should not be higher than 2 to 3 m., whereas that one at Prag is as high as 9 m. On discussion with Prof. Smetana, Director of the Prag Laboratory, I found that the experiments that are usually carried on in his Laboratory require very high heads and he wants to have as much head as possible available. It is well to remember that Prof. Smetana's Laboratory has been built to meet the special problems of Czechoslovakia, that found herself after the War separated from Germany and Austria faced with the necessity of generating power without coal or petroleum. She turned to her only river Moldava and started harnessing it for power generation. This laboratory has been built to control the river with a certain degree of security.

3. A general concurrence of opinion appeared to be that it is much better to measure the water surface in an experiment directly by means of a pointer from above than to take it in a side vessel connected with the main flow by means of a pipe. Of course the latter method has got this advantage that once the water surface is to be measured in a side vessel where the movement of the level is negligible, highly accurate technique can be applied. In spite of this advantage it is coming to be recognised that bore holes for the gauge wells can never be accurately placed and if the streamlines are not exactly perpendicular to the bore which is very unlikely in turbulent flow, there is a danger of false reading. Hence water-levels are read in the open by pointers every 10 sec. about 20 times continuously and then averaged out. It is found that this gives better level than the gauge well readings.

There are a number of special problems that are coming to be recognised as being amenable to model experiments. Mention has already been made about one of these, movement of silt in canals and rivers. Another is the problem of seepage in a porous medium such as the sand. It was Darcy who first derived the empirical law of flow associated with his name; but it was Forchheimer[6] who first attacked this problem theoretically and showed how the movement in such a medium follows some well-known definite laws. Forchheimer's deduction is based on the assumption that the movement of water in a porous medium is capillary. Experiments have not been conducted to prove this. The series of experiments that are at present being carried on in the Punjab Irrigation Research Institute will prove or disprove this definitely. However the argument of the Vienna School is something like this. It having been established that movement in such a medium is laminar experiments on models follow as a matter of course. In Prof. Schaffernak's Laboratory at Vienna such model experiments are done now more or less as a routine work; and Prof. Schaffernak thinks that with the theoretical treatment of these problems on the lines suggested by Prof. Forchheimer and with the experimental simplification arrived at by him in his laboratory, it is possible to calculate the probable seepage from a dam or a canal, the expected safety of a weir or dam foundations against blowing up. Model results in this field have come to be recognised here as reliable as those in any other cases of hydraulic experiments; and the model laws in this case being better known and understood it is possible to transfer all model results to the full-scale structures, with a greater degree of confidence than in any other fields of hydraulics. Prof. Schaffernak and his assistant Dr. Dachler have reduced the whole thing to such a state that they can predict the safety of a dam or a weir, or the seepage from a canal with a fair amount

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6 "Zur Grundwasserbrurgung nach Isothermischen Kurvenscharen, Prof. Phillip Forchheimer, *Wien*, 1917.

of accuracy. Whenever a problem is referred to them they put the model (generally to a scale of 25 : 1) in a sand tank and run the experiments for a certain length of time and photograph a few streamlines with colouring dyes. This photograph with a few certain other data of the experiment is analysed in a very ingenious way[7] and they know how the prototype is going to behave under similar conditions. Of course the porosity of the soil below the prototype forms an important factor in this behaviour. In river constructions particularly it is known that the soil medium is stratified. This stratification alters the course of streamlines and pressure gradients in a very marked way. This has also been tackled by the Vienna School. How to take account of the heterogeneity of the soil has been considered by Prof. Terzaghi and forms an interesting chapter in his book "Erdbaumechanick". So between Forchheimer, Schaffernak and Terzaghi they claim to have solved this problem of seepage and safety of dams more or less completely and they claim very close agreement. It will be seen that their whole claim rests on the assumption of Forchheimer which if not supported by experiments the whole superstructure falls.

The above is a very short account of my experience during my last visit to the principal hydraulic laboratories of the West. I am afraid some of the points require amplification and it is hoped to deal with them more at length in some future issue.

[7] "Versuchstechnische Lösung von Grundwasserproblemen". Prof. F. Schaffernak and Dr. R. Dachler, *Die Wasserwirtschaft Jahrgang*, 1931, heft 1 and 3.

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## The Study of Plant Tissue Fluids. A Critical Review.

By B. N. Sastri and M. Sreenivasaya.

(*Department of Biochemistry, Indian Institute of Science, Bangalore.*)

PLANT physiologists have interested themselves in the study of saps which represent the nearest phytological analogue of blood. The great success achieved by physiologists in the field of clinical chemistry, has stimulated the investigation of tissue fluids which regulate all the principal metabolic processes in plants. A study of the sap should give a closer insight into the metabolic changes in the plant than that obtained by an investigation of the whole tissue which includes the static reserves and the physiologically inert structural units comprising the plant organism.

Tissue fluid studies have proved useful in elucidating the nature of the physiological changes accompanying the (*a*) various phases of growth, (*b*) changes of environment and season, (*c*) manuring, and (*d*) onset of diseases. Valuable information has been obtained with regard to the suitability of a particular soil for the cultivation of a given crop. The fact that the fluid of the tea leaf has a pH value of 4·3—4·5, is an indication that the crop prefers an acid soil and instances are known where liming of tea soils and attendant reduction in acidity, has proved detrimental to tea growth.[1] The analysis of indigenous plants has provided significant indication regarding the suitability or otherwise of the area for the introduction of related exotics.[2] Tissue fluid studies have been employed with more or less success for obtaining information regarding the biogenics of essential constituents of plants; establishing varietal differences of crops [3-7] for elucidating the nature of drought [8-13]

[1] Cooper, *Ind. Tea Ass. Sci. Dept. Quart. J.*, 1925, pt. iv, p. 130.

[2] Harris *et al*, *J. Agr. Res.*, 1924, **27**, 893.

[3] Balls, *Proc. Camb. Phil. Soc.*, 1914, **17**, 467.

[4] Harris, Gortner and Lawrence, *J. Phys. Chem.*, 1921, **25**, 122.

[5] Harris, Gortner and Lawrence, *J. Gen. Physiol.*, 1921, **3**, 343.

[6] Harris and Popenoe, *J. Agr. Res.*, 1916, **7**, 261.

[7] Newton and Martin, *Can. J. Agr. Res.*, 1930, **3**, 336.

[8] Gortner, Hiffman and Newton, *C.A.*, 1924, **18**, 2543.

[9] Pantanelli, *C.A.*, 1919, **13**, 1602.

[10] Harvey, *J. Agr. Res.*, 1918, **15**, 83.

[11] Dexter, Tottingham and Graber, *Plant Physiol.*, 1932, **7**, 63.

[12] Salmon and Fleming, *J. Agr. Res.*, 1918, **13**, 497.

[13] Maximov, *Protoplasma*, 1929, **7**, 259.

and disease[14-17] resistance, for revealing the nature of relationship between hosts and parasites,[18] for determining the nutritional requirements of plants,[19-23] for evaluating the vitaminic content of potable juices and more recently, in a study of the plant viruses.[24,25]

### THE CHOICE OF TISSUE FOR ANALYSIS.

In the above studies, choice of tissue is an important consideration which determines the success of the investigation. In a study of the functional disorder brought about by disease as reflected in the composition of the tissue fluid, the most sensitive tissue suffering the maximum metabolic disturbance has to be chosen for the study. The leaves are usually the most sensitive of plant organs, and show the changes in a pronounced manner.

The choice of tissue for study will also depend upon the nature of the problem. Biogenetic studies of constituents involve mostly the investigation of those tissues where the constituents tend to accumulate. A study of the physico-chemical relationship between the host and parasite involves an examination of their root systems if one is dealing with a root parasite like *Santalum Album* Linn.

In a study of the changes induced by environmental conditions, the most susceptible tissue has to be chosen, as otherwise, the difference may not be significant. In developing methods for diagnosing a disease, for example, the tissue that has to be chosen for examination should be the one which has suffered the most drastic change. In the study of the spike disease of sandal, the most significant changes are to be found in the leaf.[26]

The scope of our choice of tissue is unfortunately limited by the special anatomical structure of plant organs which renders an easy differentiation and separation into specific tissues extremely difficult and tedious, with the result that one invariably encounters a mixture of two or more kinds of organised tissue fluids, instead of one specific fluid. This circumstance leads to several complications not only in securing a truly representative tissue fluid but also in the subsequent interpretation of results and renders certain types of investigations extremely difficult. Attempts have, however, been made through which it has been possible to obtain a single type of tissue fluid in a predominant proportion.[27]

It is, however, possible to differentiate broadly the leaf tissue fluid from the one derived either from stem or root, and such a distinction is in most cases fortunately sufficient.

### FACTORS INFLUENCING THE COMPOSITION OF SAP.

The expression of sap from tissues in a state which represents its true condition in the cell is the ideal which the biochemist has in view. This is a difficult ideal to attain for the simple reason that the sap of the individual cells widely vary both in composition and concentration.

It is possible that in the course of the preliminary operation of tissue disintegration and mincing preceding the expression of sap, alterations in the composition of the sap are brought about by (*a*) mutual precipitation of constituents, (*b*) adsorption by the insoluble tissues of the plant, (*c*) contamination with the contents of intracellular, special or dead cells, and (*d*) the bio-chemical processes accompanying the process of extraction. The sap thus obtained therefore represents only a mixture, with an average composition of saps derived from the numerous cells of varying types. It is therefore clear that one can obtain only a mixture, perhaps representing an average composition of sap derived from the numerous cells of a particular type.

### COLLECTING, SAMPLING AND PRESERVATION OF TISSUES FOR STUDY.

The large diurnal variations in the composition of the tissue fluids indicate that the collection of the samples should be carried out at a specified period of the day.

14 Degli Atti, *C.A.*, 1920, **14**, 2010.
15 Hurd, *J. Agr. Res.*, 1924, **27**, 725.
16 Hurd, *J. Agr. Res.*, 1923, **23**, 373.
17 Ranker, *J. Agr. Res.*, 1930, **41**, 613.
18 Harris and Lawrence, *Am. J. Bot.*, 1916, **3**, 437.
19 Gilbert and Harden, *J. Agr. Res.*, 1927, **35**, 185.
20 Pettinger, *J. Agr. Res.*, 1931, **43**, 95.
21 Böning and Boning, *Biochem. Z.*, 1932, **247**, 35.
22 Gilbert and Smith, *Soil Sci.*, 1929, **27**, 459.
23 Gilbert, McLeon and Adams, *Plant Physiol.*, 1927, **2**, 139.
24 Nelson and Breese, *J. Agr. Res.*, 1930, **41**, 749.
25 Matz, *J. Agr. Res.*, 1933, **46**, 821.
26 Sreenivasaya and Sastri, *J. Indian Inst. Sci.*, 1929, **12A**, 239.
27 Mason and Maskel, *Ann. Bot.*, 1928, **42**, 190.

The plant from which samples are to be collected should enjoy similar ecological conditions since variations in shading and sunshine affect the composition of the sap. When the object of the investigation is to compare the compositions of the tissue fluids derived from the healthy and spiked sandal leaves or those from attacked and free lac hosts, the samples should be obtained from plants having similar conditions of environment. In spite of all the care bestowed in the selection of samples, individual differences due to unknown factors, still persist from plant to plant. In such cases, "random sampling" from a large number of apparently similar individuals is the best course to be adopted. Wherever permissible such studies should be extended over a protracted period and the results subjected to statistical analysis. It is also necessary to carry out a preliminary study of the limits of variation of the factor for which the study is undertaken for given area, by analysing a large number of samples taken at random. The effects of a treatment imposed or a variation under study, will become significant if the limits of variation after the treatment are distinctly large.

Among other factors which affect the composition of the tissue fluid and which should accordingly be taken into consideration while collecting samples may be mentioned the height or insertion of the tissue from the ground, degree of suberisation in the case of stems, and freedom of tissue from adhering foreign matter which should be removed by careful brushing and washing with water. If the laboratory is situated at a distance from the seat of sampling, the tissues must be transported quickly in an ice-chest so as to minimise changes.

### METHODS OF EXTRACTION—A COMPARATIVE STUDY.

A review of the methods can be obtained elsewhere.[28-29] Generally speaking, the methods in vogue are (*a*) pressure extraction after rendering cell walls permeable to the sap by a suitable preliminary treatment, and (*b*) centrifugal methods. The first method is the one largely employed, the preliminary treatment consisting in exposure of the tissue to toluene or chloroform vapour or to intense cold by surrounding the tissue in liquid air, solid $CO_2$ and various cryoscopic mixtures like solid $CO_2$ and acetone.

A pressure method due to Dixon[30] and later used by Chibnall and Groover[31] consists in enclosing the tissue in a cylinder with the cut ends exposed. Compressed air is admitted into the cylinder, and when the pressure reaches 20–22 atm. to the square inch, the juice flows out at the cut ends. Preliminary treatment of the tissue with plasmolysing materials is found to be necessary.

Methods such as the flushing out of the sap under reduced pressure by means of water, have also been used. This method offers great possibilities but has received comparatively very little attention.

Comparative studies of the various freezing agents have been made. According to the work of Meyer[32] there is little or no difference in osmotic pressure between the samples of fluids expressed after freezing the tissue by liquid air, solid $CO_2$ and in salt mixture. Comparative studies by us between liquid air and toluene treatments with several types of plant material, revealed no significant differences. Whatever be the treatment, leaf tissues offer little difficulty; with stem, however, a preliminary mincing of the tissue was found essential[33] to secure concordant results with respect to concentration and yield of tissue fluid. Sayre and Morris[34,35] have studied the effect of size of samples on the yield of the tissue fluid and found that larger percentages of sap were removed from the smaller samples, under uniform pressures and times of draining. From these considerations it is clear that the following factors have to be standardised: (*a*) Extent of tissue disintegration particularly with the stem tissue, (*b*) quantity of sample, (*c*) pressure of extraction, and (*d*) time of extraction. The method which has been in use in our laboratory and has given satisfactory results has been described by us elsewhere.[36] We have replaced liquid air by

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[28] Meyer, *Plant Physiol.*, 1929, **4**, 103.

[29] Sayre and Morris, *Plant Physiol.*, 1931, **6**, 139.

[30] Dixon, *Sci. Proc. Roy. Dub. Soc.*, 1921, **17**, 263.

[31] Chibnall and Groover, *Ann. Bot.*, 1920, **40**, 491.

[32] Meyer, *Am. J. Bot.*, 1928, **15**, 449.

[33] Krishna, *Thesis for the M.Sc. of the Bombay Univ.*, 1929.

[34] Sayre and Morris, *Plant Physiol.*, 1931, **6**, 139.

[35] Sayre and Morris, *Ibid.*, 1932, **7**, 261.

[36] Sreenivasaya and Sastri, *J. Indian Inst. Sci.*, 1928, **11A**, 24.

toluene treatment; the minced material is placed in a well-stoppered bottle, toluene added, and the bottle immersed in a freezing mixture of ice and salt for 10-12 hours. This modification has been found to yield comparable and concordant results.[37] The fluid obtained at 1 ton pressure to the sq. inch is centrifuged at 3000 R.P.M. for 15 mins. to free it from all debris and the clear centrifugate used for subsequent analysis.

## Artificial Culture of the Male Gametophyte of *Ephedra foliata* Boiss and *Ephedra Gerardiana* Wall. and a Study of the Number and Morphology of their Chromosomes.

By Pran Nath Mehra, M.Sc.
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*EPHEDRA FOLIATA* Boiss (*E. peduncularis* Boiss) is a native of the Punjab plain. Plants of *E. Gerardiana* Wall. (*E. vulgaris* Hook. f.) were raised in the Government College Botanic Garden, Lahore, from seeds brought by Prof. Kashyap from Zanskar (about 12,000 ft. above the sea) and sown in October 1928. The plants produced flowers for the first time in 1933. In its natural habitat at high altitudes the flowers of *E. Gerardiana* appear during June and July and the seeds are set in the later half of August. These ripen by the end of September before the onset of the severe winter which brings the period of vegetative activity to a close and the plants enter the dormant phase of life to resume their activity during the next summer. The conditions are different in the Punjab plain. The period of vegetative activity is during the spring months of March and April. The plants of *E. Gerardiana* bear flowers during this period —from the middle of March to the middle of April—this period coinciding with the flowering period of the native *E. foliata*. After this the seeds are set which ripen about the middle of May. The plants then enter the resting period because of the strong heat of the plains.

The spindle-shaped pollen grain at maturity possesses a sculptured exine with ridges running longitudinally from pole to pole. Remains of two evanescent vegetative cells on one side, a stalk nucleus embedded in the peripheral part of the cytoplasm of the naked body cell in the centre and a rather large tube nucleus at the other end completes the structure of the pollen grain at the time when it is shed.

The pollen grains were germinated on the mucilaginous secretion that oozes out of the ripe ovules, placed on glass slides kept in a moist chamber. It is possible to germinate the pollen grain of one species on the mucilage secretion of the other. The secretion absorbs water from the surrounding atmosphere of the glass chamber and gets diluted. The grains gradually absorb the nutritive medium, swell in size, and at the same time prophasic changes start in the body nucleus. On the pollen grain becoming highly turgid the exine ruptures by two splits starting on opposite sides from the tube nucleus end of the grain and extending to about the middle of its length. This throws out the grain bounded by the intine with a jerk from the inside of the outer coat which immediately undergoes torsion. Thus liberated the grain increases to about double its former length. By this time the body nucleus is in the mid-prophase or early metaphase stage. All the further changes take place outside the exine in the medium. The total time for the complete division of the body nucleus and the organisation of the two male nuclei on the opposite poles is about five hours from the time the pollen grains are put into the secretion.

The pollen tubes are given out after about six to eight hours. From one to as many as four or more tubes may be given out from different sides of a grain, sometimes in a most irregular manner. More commonly only a single tube is given out usually laterally from just near the tube nucleus end of the grain but it may grow out from the mid-lateral position, or as a direct continuation of its tube nucleus end. When a number of tubes are given out, only one develops further, and the others remain

[37] Narasimhacharya and Sastri, *J. Indian Inst. Sci.*, 1931, **14A**, 2.

small and empty except for a thin lining of cytoplasm along the wall. Tubes growing in the medium for a period of 48 hours become quite elongated (attaining a length of 600-700$\mu$) hyaline, and vacuolated and if kept for a longer period show signs of the degeneration of the male nuclei. The latter by the time they enter the pollen tubes from pollen grains have already increased considerably in size and the further growth takes place in the tubes.

The germination of pollen grains has also been tried on different strengths of sachharose solution in water. There is practically no germination in 10% and 20% solutions. The germination in 40% solution is better than in 30% and the former strength is perhaps the best for securing germination, but by far the best results are obtained in the natural mucilage secretion described above.

A new method has been evolved for making cytological investigations of the number and morphology of the chromosome of the species by making smear preparations of the germinating pollen grains at the time when the body nucleus is undergoing division.

The pollen grains are germinated on glass slides in suitable media—mucilage secretion from the ripe ovules being utilised in the present case. After the exine is ruptured the body nucleus in the grain is to be found at the different stages of mitotic division from mid-prophase onwards, the early prophasic changes having occurred before the rupture of the exine. The grains are now fixed by putting two or three drops of the desired fixative on the slide. Out of a number of fixatives tried Bouin's fixative with Allen's modification P.F.B$_{15}$ gave decidedly the best results, the second best being Flemming's for Gasteria and smear method (W.R.T.) and Flemming's weak solution with only a few drops of osmic acid (not so much as is described in the original formula) which are excellent for prophasic stages. The fixative is allowed to act for two to four hours but a prolonged action of the fixative upto twelve hours does no harm. The fixative on the slide should not be allowed to evaporate and the slide is therefore kept in a moist chamber. The most delicate part of the process now is the handling of these microscopic objects.

A clean slide is smeared with Meyer's albumen as in ordinary paraffin technique and the drop of the fixative with the grains suspended is poured on to it. This is now spread uniformly over the slide by gently tilting the slide in various directions. If the fluid is not enough a drop or two of water may be added. This is done to ensure the uniform distribution of the grains over the slide. A long cover-slip is next placed upon the slide just as in making balsam mounts. The liquid is then carefully sucked out by gently placing a piece of blotting paper on one side of the cover-slip. Some of the grains may be sucked out by the current but mostly they remain in position. This suction is continued to such an extent that any further withdrawal of water introduces air bubbles under the cover-slip. The pressure exerted upon the grains by the weight of the cover-slip reinforced by the adhesive force of the disappearing water on the cover-slip is sufficient to fix the tiny objects to the albumen coating on the glass slide. The cover-slip is now removed by flooding the slide with water and gradually and carefully sliding away the cover-slip preferably under water when the force of buoyancy facilitates the process a great deal. Some of the grains are sure to be washed away during this process but a large number of these stick to the slide.

The next process is washing. If the fixation is done in chrome-acetic mixture the slides are washed in ordinary Stender dishes in flowing water at least overnight. If Bouin's fixative is used, the process takes a longer time but gives excellent results. The slides are first washed in water for about five minutes to remove the superficial fixative and then passed through the various grades of alcohol to remove all traces of picric acid. In 30%, 40%, 50% they are kept at least overnight in each. They are then passed back in the reverse order through the successive lower grades keeping in each for about four hours till they are brought back into water. The washing is further completed in running water for about four to six hours. This process must be strictly followed to ensure the complete removal of the fixative before proper brilliancy of stain in the preparation can be obtained.

The slides are now ready for staining in the usual way. Two to three hours mordanting in iron-alum and 2-3 hours staining in ½% Haematoxylin give excellent results. The chromosomes and chondriosomes take

a jet black stain against the greyish white background of the cytoplasm.

An important point in mounting the preparations in balsam is that the balsam should be thin, otherwise the grains are liable to undergo plasmolysis.

This process described above possesses several distinct advantages over those usually in vogue for the study of the chromosomes in plants. The tediousness of cutting microtome sections is avoided. As in the "Pollen Mother Cell Smear Method" the greatest advantage that is secured is the immediate fixation of the living material by the direct contact of the fixative used—a feature which is most essential in delicate cytological works where it is highly desirable to get accurate results with least possible distortion of the original features present in the living condition. A number of fixatives can thus be tried within a relatively short period for testing their efficiency. A distinct advantage over the "Pollen Mother Cell Smear Method" is that on account of the reduced number of chromosomes in the gametophyte, the number of chromosomes and the form of the individual chromosome are ascertained with greater ease and accuracy, since the congestion due to the double number of chromosome is avoided and this is particularly advantageous in cases where the chromosome number is large. Another advantage is that with a little skill different stages in the mitotic division of the body nucleus from the prophase onwards to the formation of distinct male nuclei (and even the later stages when these increase in sizes) can be secured on the same slide. This is most essential in following the alteration in the chemical nature of the chromosomes as they pass through the various phases, so far as these are exhibited by their reaction to the stains, since in the same slide, the period of mordanting, staining and destaining remains constant for the chromosomes at the different phases of nuclear division.

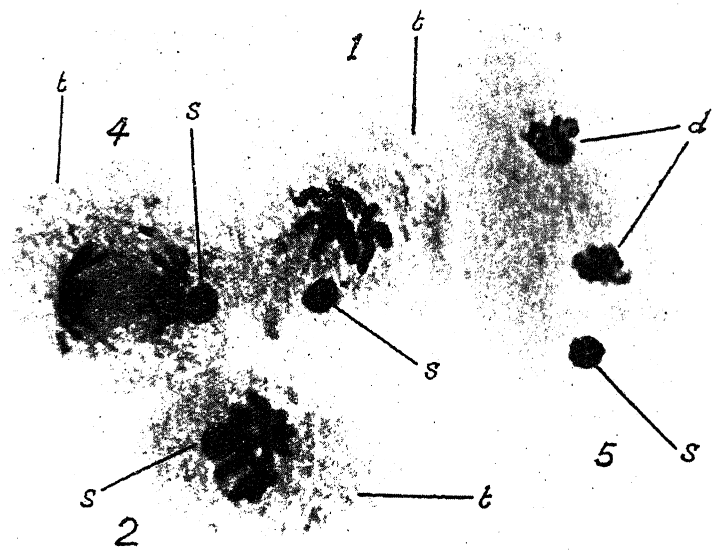
So far as the writer is aware, no such method of working out the number and morphology of the chromosomes in plants from a study of their male gametophytes grown under artificial cultural conditions, has been described previously by any other author.

The technique above described for handling microscopic objects can be utilised with great advantage for making detailed cytologic investigations of such minute objects as Desmids, Protococcus, etc., which are otherwise difficult to handle. The previous method of making cytologic studies by microtomic sections of such minute organisms involves a great wastage of the material during the passage through various grades and is not capable of easy handling. This method can be utilised with greater ease and without unnecessary wastage of the material.

It can be stated definitely from the author's observations that the haploid number of chromosomes in *E. foliata* is seven. Three of these possess median fibre attachment constriction and are V-shaped. One of these three probably possesses a secondary constriction in one of the arms. The other two possess submedian fibre attachment constriction and the length of the longer arm is about 1½ times that of the shorter. They are further distinguished from one another by the larger size of one of these as compared to the other. The remaining two chromosomes have sub-terminal fibre attachment constriction. One of these again is smaller than the other and possesses a satellite at the end of the longer arm.

Similarly, the writer is in a position to state definitely that the haploid number of chromosomes for *E. Gerardiana* is undoubtedly 14—thus showing diploidy over *E. foliata* which possesses the basic number 7. The diploidy, however, is limited only to the number of chromosomes and not with respect to the type of chromosomes or in other words the chromosome compliment of *E. Gerardiana* does not show an exact duplication of the type of chromosomes met with in *E. foliata*. In *E. Gerardiana* 4 chromosomes possess median fibre attachment constriction and one at least of these possesses a trabant or satellite at the end of one arm and a secondary constriction at the end of the other. Six possess sub-median fibre attachment constriction, three possess attachment constriction which might be regarded as intermediate in position between sub-median and sub-terminal and one possesses sub-terminal fibre attachment constriction.

That the constant position of the fibre attachment constriction in chromosomes is a feature of great importance in the identification of different chromosomes in a complement is clearly realised in the present study. The attachment constriction becomes apparent in each chromosome as early

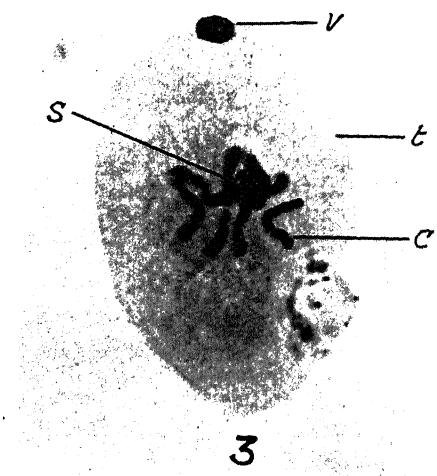



as the mid-prophase and most clearly in the late prophase while the wall of the nucleus is still intact and long before the appearance of any spindle fibres.

An important difference from the observations of other investigators is that the form of the chromosomes does not remain constant during the different phases of mitosis and therefore cannot be relied upon in the identification of the chromosomes.

Chondriosomes are found irregularly scattered or regularly arranged in the cytoplasm of the body cell in preparations fixed in chrome-acetic acid mixtures. Each is found to possess what looks like a vacuole in the centre and these chondriosomes stain jet black with iron-alum hæmatoxylin. In preparations fixed in Bouin's fluid, the chondriosomes are either completely absent or present a faded appearance. It seems they are in some way chemically altered by the action of the fixative. In living specimens the chondriosomes appear as refractile granules in the cytoplasm of the body cell.

I express my deep sense of gratitude to Dr. S. R. Kashyap under whose guidance this work was carried on for very kindly allowing me to use the material from the Government College Botanic Garden and for critical and other valuable suggestions made during the course of the present investigation.




The photographs are of the germinating pollen grains of *Ephedra foliata* Boiss, showing the body nucleus at various stages of mitotic division.

**Figs. 1, 2 & 3.**—Body nucleus at metaphase : in Fig. 3, seven chromosomes can be clearly made out. *c*—chromosome.

**Fig. 4.**—Late anaphase.

**Fig. 5.**—Beginning of telophase. *d*—daughter nuclei being organised.

*v*—remains of the vegetative cells, *s*—stalk nucleus, *t*—tube nucleus.

# The Control of Insect Pests of Indian Fruits.

Dr. S. M. Das, D.Sc.
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FRUIT-GROWING is indeed one of the oldest occupations of the people of India, which will not appear at all strange if one keeps in mind the immense number of delicious fruits that thrive on the Indian soil even in a state of nature, that most fruit trees are perennial and once grown yield annual products for a large number of years, and finally the comparative ease with which they can be grown from seed, cutting and graft. But it does appear strange that with all these facilities India at present imports a large amount of fruit from other countries, whereas normally it should be able to export a variety of fruits to the different markets of the world.

The Indian fruit-grower works under a large number of handicaps not the least of which is the general mental apathy towards modern methods of fruit-growing. Recently, however, the fruit-growers of U.P. have given a lead in the matter by meeting together and considering the ways and means by which the fruit-growing industry could be improved by the application of modern methods. Now one very important factor that controls the productivity of an orchard is its insect pests. It is not unusual in certain years to find the whole crop of an orchard utterly destroyed by a certain pest; but it is usual for the average Indian fruit-grower to accept this as an inevitable calamity incapable of being averted by human agencies. They have not yet realised that the pests are more or less their own making and as such can only be controlled by measures adopted by themselves, a fact which has been amply demonstrated in the western countries.

Plants and insects exist in nature in a state of perfect balance and their specific numbers are more or less the same from year to year. No serious insect pests, as a matter of fact, exist for any one species of plant in its natural habitat. Nature's control of pests is three-fold. The weather may be favourable or unfavourable, insectivorous birds may be exceptionally partial to some, while entomophagous (insect-eating) insects play a not inconsiderate part in keeping the pests under control. All this constitutes what is familiarly known as the "*balance of nature*". But cultivated plants do not live in any such equilibrium. The mere fact of cultivation of the soil at once alters the whole state of things, for it modifies not only the number and kinds of plants but also the physical condition of the soil, its temperature and water and air content. In nature we do not find a great aggregation of the same species of plant such as man establishes in the form of orchards containing only oranges, apples or plums, with the necessary aggregation of insects that feed on them. The depredations of these insects can only be controlled by destroying them in one way or another. It is not essential that an insect should be attacked in its harmful stages; on the other hand, it is often much easier to destroy a pest in its harmless stages than in the harmful ones. Much depends, therefore, on the proper working out of the life-history of the pest concerned.

There are various kinds of insect pests that attack orchard-crops. From amongst the forms that have no wings in any stage of their life-history the spring-tails are known to do some damage to fruit trees; while all the other pests have wings in some stage or other. Amongst the latter are the notorious white-ants, thrips, aphids and scale insects, bugs, caterpillars, weevils, saw-flies and fruit-flies. They attack not only the roots, stem and leaves of a tree but extend their ravages to seedling, shoot, flower and fruit. But it is possible to control this weird horde of parasites because each species of fruit-plant is attacked fatally by only a few definite species of insects; and one can usually avoid serious damage to a certain orchard-crop by controlling a few species that may have otherwise done any considerable harm to the crop. For example, there are only two serious pests of the pomegranate (both butterfly larvæ); and two beetles, a caterpillar and the wooly aphis is all that the apple crop can succumb to. It should be borne in mind, however, that very often the number of species attacking a crop is inversely proportional to the actual aggregate of the individuals comprising the species, an idea of which may be obtained by observing migrating aphids.

Methods for controlling the pests may be

either *direct* or *indirect*. In the direct control measures the aim is actually to kill the insect by the application of some toxic substance or by mechanical means whereas indirect measures affect the conditions in which the insects may thrive. Of the various direct control measures adopted sprays and washes are indeed the most important. Now it is known that certain insects (*e.g.*, caterpillars) obtain food by biting off and chewing bits of plant tissue while others (*e.g.*, aphids) suck off plant juices by piercing into the tissues. It is apparent that different measures should be adopted for these two classes. Chewing insects are easily destroyed by the spraying of stomach poisons on the fruit tree or plant attacked which prove fatal to the insects when eaten along with their food; whereas contact poisons are used for sucking insects which are applied directly on their bodies. The problem is to find substances that will neither scorch the plant nor be too weak for the insects. For example, copper sulphate solution used on leaves may kill the plant, and therefore lead arsenate solution is used instead Again raw oil usually scorches the plant whereas oil emulsion can be safely used.

In the west, lead arsenate solution is used as stomach poison; but as it is dangerous for man and cattle if not handled properly lead chromate should be used in Indian orchards. A solution of 1 lb. in 32 gallons or $1\frac{1}{2}$ oz. in 1 kerosene tin of water will be quite efficacious; but in case of bad attacks the strength of the solution may be doubled. A hand sprayer (in the case of small trees) or a wheel sprayer should be employed and a fine spray spread over buds, etc., evenly until every leaf becomes yellow. If the leaves do not wet easily a little *rosin compound* solution should be added to the mixture. This if applied properly will successfully keep in check all kinds of caterpillars and weevils that do so much damage to foliage, flower and fruit. As contact poison either *rosin compound*, *crude oil emulsion* or *vermisapon* may be used. *Rosin compound* is easily prepared by powdering 2 lbs. of rosin, boiling 1 gallon of water with 1 lb. of washing soda, then adding the rosin and boiling again. Water should be added from time to time during the last process to make the solution upto three gallons. For use 4 pints of this should be made up to 4 gallons with water. *Crude oil emulsion* consists of 20% of soft (fish-oil) soap with 80% of crude mineral oil; for use $\frac{1}{2}$ pint of emulsion should be stirred in one kerosene tin of water. *Vermisapon* can be used in place of crude oil emulsion. In practice these should be sprayed with some force into the buds, fruits and branches so that they may come in close contact with the insects. All sucking insects, except the mealy bugs and scale insects, are destroyed by this method. For the latter a solution of nicotin or nicotin sulphate with soft soap is very effective. 6-12 fluid ounces of nicotin and 2-3 lbs. of soft soap in 100 gallons of water should be used. Spraying of fruit trees (such as apple) to check fruit-boring insects should be done after the petals have fallen when the young fruit is just set; it should not be done whilst the trees are in full bloom. Washes, though not so important as sprays, may be beneficially used when the plants are dormant. Caustic soda wash, lime wash and tar distillate —all serve to kill moss, lichen and eggs of aphids and apple-suckers.

In addition to sprays and washes a few other accessory measures may help in completely controlling the pest. *Hand-picking* is very useful when the insect is just appearing. Egg-nests, insect-nests and attacked fruits and leaves should be removed and either burnt or buried deep under the earth. This is effective against apple-sawfly in fruits, pear-leaf-blister mite in leaves and apple-blossom weevil in the closed capped blossoms. *Running of poultry* in orchards effects the destruction of most pests that pass a part of their life-cycle in the soil. *Banding of trees* for pest that crawl up and down the trunk is another effective measure against some caterpillars and beetles. A band of sticky material or bands of hay and sacking should be placed half-way up the trunk which detain insects and may be burnt later. Finally, root-pests like the wooly-aphis of the apple can only be successfully destroyed by *soil-fumigants* like carbon di-sulphide. But this should be done under expert supervision as otherwise the reagent may injure the plant itself.

Indirect measures of control will often enable the fruit-grower to considerably reduce the severity of the insect attacks. For example, some insects have their winter quarters in rubbish, moss and lichen, and if these be removed, however favourable the summer conditions may be, the pests cannot thrive. It is much better, therefore, to completely destroy badly infested trees

rather than clean them. Another method of minimising the harm done by insects is to make the trees more resistant to insect-attacks. This immunity can be obtained by starting from immune breeds, to determine which the difference in susceptibility already shown by the marketed fruits may be taken into advantage. But standing crops will gain much in the matter of immunity if proper food supply is given and a general clearing up of the orchard maintained.

A very interesting control of insect-pests, little of which is known and still less used in India, is their *biological control.* This method of control has been tried on a large scale in the West and has been found signally successful. Biological control takes advantage of the fact that certain insects prey upon other insects in one stage or another of their life-history and has succeeded in so breeding, introducing and naturalising one or more species of parasites of an insect-pest in the region where the latter thrives that the parasitic species have completely subjugated the pest in that region. Special breeding stations are formed from where millions of parasites are distributed to the various fruit-growers who release them in their orchards. Needless to say that specialists must first be employed to discover the parasites which attack a definite species of pest. All this is done in the West by forming an association of fruit-growers and maintaining an efficient staff of specialists at their own cost. A similar move in India will not be less paying than it has been in countries where this has been tried and not found wanting. It may be pointed out here that in the artificial control of insect-pests one should be careful not to destroy friend and foe together, for then the epidemics may be more virulent than when the things were left to nature.

It is expected that Indian fruit-growers will take full advantage of methods that have been tried over and over again for the suppression of insect-pests of orchard crops and which, with its little necessary expenditure, will increase the annual output of an orchard by 25%. When all is said one may remind the fruit-grower that as with the human body so with the best cultivated orchard, a 'doctor' is always required to keep it in a condition of maximum efficiency.

## Letters to the Editor.

### A Note on the Embryo Sac of *Sagittaria sagittifolia* L.

IN a recent paper Prof. K. V. O. Dahlgren[1] has described the development of the female gametophyte in *Sagittaria sagittifolia* and finds it to have a six-nucleate embryo sac arising in the same way as described for some other *Alismaceæ* in his earlier paper[2]. My material collected from Lucknow in February 1934 shows some variations in the number of nuclei in the mature embryo sac.

Upto the four-nucleate stage the embryo sac develops in the same way as described by Prof. Dahlgren. Usually the two chalazal nuclei do not divide further and the mature embryo sac is six-nucleate, but sometimes, one or both of them may divide producing a seven and eight-nucleate embryo sac respectively. Sometimes, the lowest chalazal nucleus of the tetra-nucleate stage may undergo fragmentation and thus increase the number of the antipodal nuclei. The results obtained by me in *Sagittria sagittifolia* agree with my previous observations on *S. guayanensis.*[3]

In his work on *S. latifolia* Schaffner[4] mentioned the presence of three antipodal cells. Cook[5] on the other hand says that there are three ephemeral antipodals in *S. lancifolia.* Dahlgren[1] criticises both of them and definitely states that there are no antipodal cells in *Sagittaria.*

[1] Dahlgren, K. V. O., "Die embryosackentwicklung von *Echinodorus macrophyllus* und *Sagittaria sagittifolia*," *Planta, Archiv für wissen., Botanik,* 1934, **21**, 602-612.

[2] Dahlgren, K. V. O., "Die embryologie einiger *Alismatazeen*," *Svensk Bot. Tidskr.,* 1928, **22**, 1-17.

[3] Johri, B. M., "A note on the life history of *Sagittaria guayanensis,* H. B. K." *Current Science,* 1934, **2**, 428-29.

[4] Schaffner, J. H., "Contribution to the life history of *Sagittaria latifolia*," *Bot. Gaz.*, 1897, **23**, 252-273.

[5] Cook, M. T. "The Embryology of *Sagittaria lancifolia* L." *Ohio Nat.*, 1907, **7**, 97-101.

I agree with Dahlgren that the six-nucleate condition of the embryo sac is typical for the family, but in all the three plants I have investigated—*Limnophyton obtusifolium* (Johri [6]), *Sagittaria guayanensis* (Johri[3]), and *S. sagittifolia*—I find that in some cases antipodal nuclei are really present and occasionally they may also organise into cells. All evidence points to the fact that Schaffner and Cook misstated the case in regarding the exceptional as the usual condition. At the same time it must be pointed out that a careful re-examination of slides may reveal the presence of more than six nuclei in some of the embryo sacs of the genera investigated by Prof. Dahlgren.

The following scheme summarises the work done so far on the development of the embryo sac in the genus *Sagittaria*:—

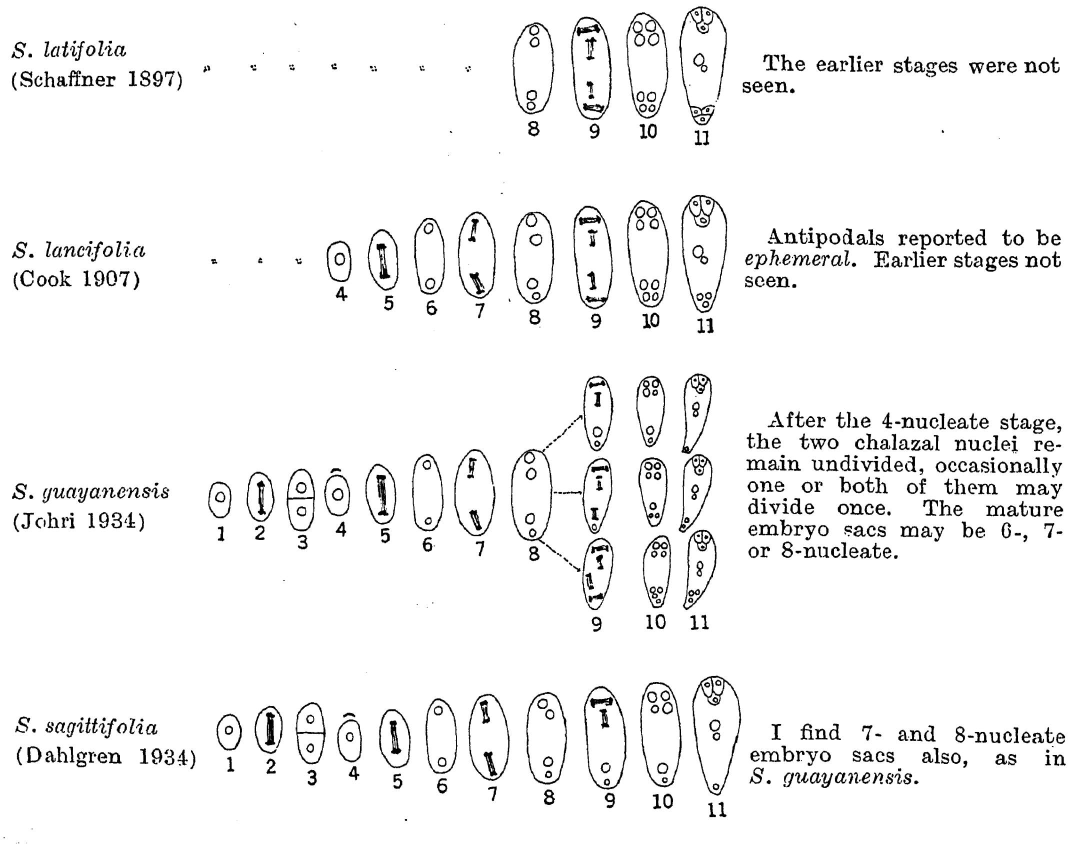


Chart showing the development of the Embryo Sac in species of *Sagittaria*.

1. Megaspore mother cell. 2. Heterotypic division. 3. Dyad. 4. Enlargement of the lower dyad cell. 5-11. Development of the female gametophyte.

I am greatly indebted to Dr. P. Maheshwari, under whose guidance the work was carried out.

B. M. JOHRI.

Department of Botany,
Agra College,
*May 26, 1934.*

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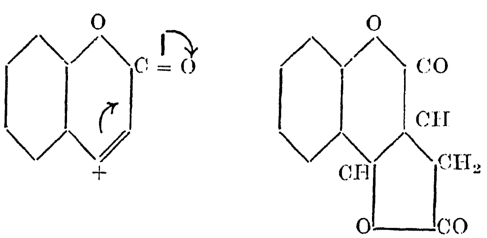
[6] Johri, B. M., "The life history of *Lymnophyton obtusifolium* Miq." *Current Science*, 1933, **2**, 99-100.

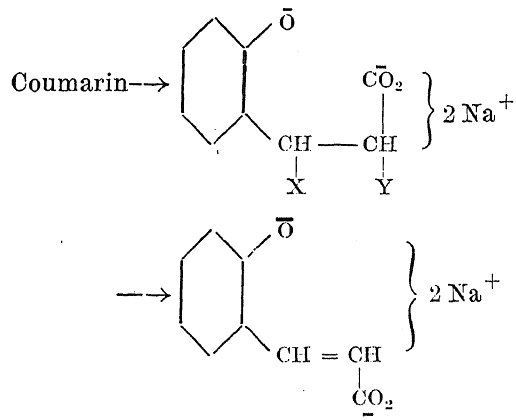
## The Mechanism of Geometrical Inversion in regard to Coumarins and Coumaric Acids.

THE facility with which geometrical inversion takes place in the acids derived from the coumarins, just as the behaviour of the coumarins in most of their reactions, is controlled by the presence of a Katio-enoid system[1,2] producing kationoid reactivity at the carbon atom in position 4. Substituents such as alkyl, hydroxyl and alkoxyl groups which act as electron sources tend to reduce the reactivity of the compound especially when they are present in the above-mentioned position.[3,4] Again the difference in properties between coumarin 4- (II) and coumarin 3-acetic acids (III) becomes easily intelligible from the above point of view. The possibility of the formation of a lactone IV[5] may also partly account for the greater stability of III when heated.



I IV

*Cis to trans inversion.*—The change from coumarin to coumaric acid takes place in an alkaline medium only and as an essential preliminary some additive reagent like NaOH, $NaOCH_3$ or $NaHSO_3$ has to add on to the double bond, temporarily at least, and thereby facilitate rotation. Several of these addition products have been isolated.[6,7,8] The process can be represented as below:—



There are, therefore, two factors which control this transformation, *viz.*, (i) addition at the double bond which renders rotation of the groups into the required position possible, and (ii) repulsion between the negatively charged O and $CO_2$ groups which forms the driving force for the change. The efficiency of the different reagents and the influence of the different substituents are clearly understood when their effects on the above two factors are analysed. In regard to the findings of Sen and Chakravarty[9] on the use of mercury compounds in producing inversion it should further be remembered that substituents like nitro, chloro and bromo groups inhibit nuclear reactivity of the benzene ring thus preventing mercuration whereas alkyl, hydroxyl and alkoxyl groups have the opposite effect giving rise to mercurated products.

*Trans to cis inversion.*—Stoermer and his co-workers observed[10] that many coumaric acids and their esters underwent geometrical inversion under the influence of ultra-violet light. Ordinary sunlight has now been found to be equally effective. Very high yields of the coumarins are obtained and in several cases the change is complete within 12 hours. Light supplies the requisite energy for converting the *trans* form into the *cis* having a higher energy content. As for removing the effect of the double bond whereby the rotation of the groups is rendered possible, addition of an addendum seems to be neither possible nor necessary under the circumstances. The following mechanism

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1 Seshadri, *J.C.S.*, 1928, p. 117.

2 Robinson, Institute of Chemistry of Great Britain and Ireland, Lecture, 1932, p. 25.

3 Seshadri, *Ibid.*

4 Heilborn, *et. al.*, *J.C.S.*, 1927, p. 2005; 1931, p. 1701.

5 Linstead, *J.C.S.*, 1932, p. 115.

6 Bühmann, *Annalen*, 1912, **388**, 259.

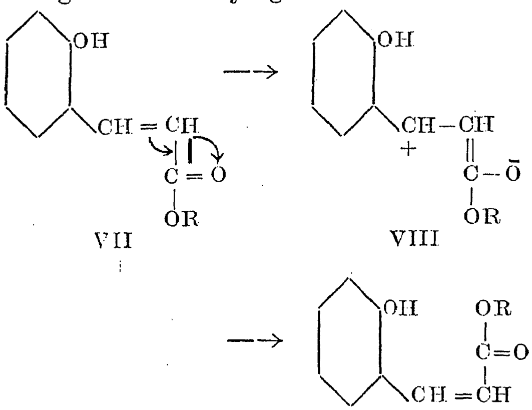
7 Dodge, *J. Am. Chem. Soc.*, 1916, p. 446.

8 Seshadri, *Ibid.*

9 Sen and Chakravarty, *J. Ind. Chem. Soc.*, 1930, p. 247.

10 Stoermer, *et. al.*, *Ber.*. 1908, **41**, 335; 1909, **42**, 4865; 1911, **44**, 640; 1912, **45**, 310.

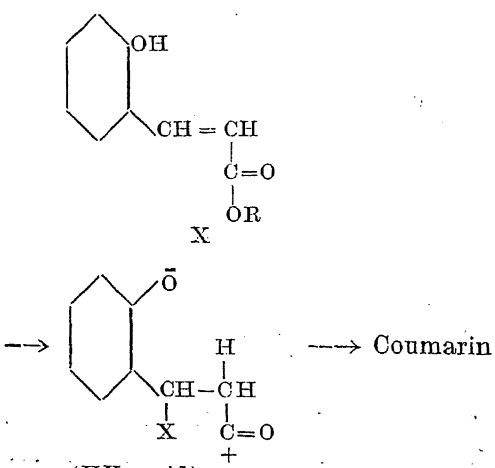
is suggested, the polarisation of the system being facilitated by light:—



VII VIII IX

The stage VIII may be formed only momentarily and once the *cis*-phase is produced it is stabilised as coumarin by the ready elimination of alcohol or water. A nitro group in the benzene ring further weakens the double bond by the positive field it creates and hence greatly facilitates the transformation whereas a methoxyl group does the opposite.

In the presence of fuming hydrochloric, hydrobromic and concentrated sulphuric acids, particularly at 100°C. the *trans* acids and their esters undergo easy conversion into the coumarins. The removal of alcohol or water seems to be the first stage in the reaction. The dipole that is formed supplies the necessary energy for the inversion and the rotation of the groups is facilitated by the temporary addition of the acids at the double bond.

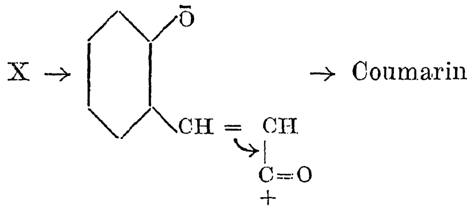


X

(HX=acid)

XI

The course of the transformation under the influence of heat at the melting points of the substances, seems to belong to a slightly different type. In the case of the esters alcohol is first eliminated and the subsequent inversion may be represented as below:—



Here the combined effect of the carbonyl group and the positive charge on the carbon atom brought about by the removal of OR eliminates the effect of the double bond. Such a process does not obviously take place in the case of the acids partly due to the greater difficulty of the removal of water and partly due to the facility with which the elimination of carbon dioxide takes place producing styrenes. Experimental details will be published elsewhere.

T. R. SESHADRI.

Chemical Department,
Andhra University, Waltair,
*May 28, 1934.*

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## On a New Method of Synthesis of Bicyclic Terpenes: Synthesis of Ethyl *cyclo*hexanone 2 : 6-dicarboxylate.

THE synthesis of this ester has been attempted in this laboratory by several methods, one of which, *viz.*, the action of sodium ethoxide upon trimethylene dimalonic ester has now yielded the desired product b.p. 140-42°/1-1·5 mm. The formation of the desired *cyclo*hexane ring by this method has been definitely established by hydrolysis and decarboxylation of the ester into *cyclo*hexanone.

Recourse has also been taken to another method for the preparation of the desired di-ester from *cyclo*hexanone-2 : 2 : 6 : 6-tetracarboxylic ester, b.p. 175°/2-3 mm. (pure product 30% yield) obtained by the action of carbonyl bromide upon the disodium derivative of trimethylene dimalonic ester. The tetra ester on being hydrolysed with alcoholic potash gives the corresponding tetra acid m.p. 246°, and is converted into *cyclo*hexanone on being boiled with 50 per cent. sulphuric acid during 16 hours. The

conversion of this tetra ester into the required diacid is being tried under regulated conditions of hydrolysis and decarboxylation. This reaction being of very general applicability has been extended for the preparation of *cyclo*pentanone and *cyclo*butanone tetracarboxylic esters by condensing ethylene and methylene dimalonic esters, respectively, with carbonyl bromide. The *cyclo*pentanone tetra ester on drastic hydrolysis accompanied by decarboxylation has given *cyclo*pentanone. It has been possible to raise the yield of ethyl butane tetracarboxylate from 15 to 65 per cent. by using magnesium amalgam instead of sodium.[1]

The *cyclo*hexanone-2 : 6-dicarboxylic ester and the corresponding *cyclo*pentanone and *cyclo*butanone diesters with two active hydrogen atoms in 1 : 3-positions should, it is expected, form convenient starting materials for the synthesis of some interesting bicyclic terpenes.

P. C. GUHA.
N. K. SESHADRIENGAR.
Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
*May 31, 1934.*

## Catalogue of Scientific Periodicals.

ABOUT a year ago in an Editorial article[2] it was suggested that one of the duties or functions of an Indian Academy of Science would be the establishment of a central library in order to facilitate scientific research in this country. The wisdom of spending in this manner so large a sum as would be required is, I think, debatable and in my opinion it would serve the purpose better if the money were used to increase the facilities available in existing libraries throughout the country. However that may be, I wish to suggest that an excellent and useful piece of work in connection with Indian libraries could be done by any central scientific body, such as an All-India Academy of Science, in preparing a catalogue of all the periodical scientific literature available in the principal public and quasi-public libraries in India.

At present it is often very difficult to ascertain in what library (even in a given city) a wanted reference may be found or whether it is available in India at all. The only catalogue of which I am aware dealing with periodicals in more than one Indian library is Kemp's "Catalogue of the Scientific Periodicals in Calcutta Libraries" published in 1918. This is already out of date and incomplete though still useful. There may be others of which I am unaware. Other countries possess catalogues of the scope suggested. For instance, the "World List of Scientific Periodicals" published in England in two large volumes contains in the first volume the titles of all the known published scientific periodicals in the world and in the second volume a reference to where copies may be found in the libraries of selected cities in Great Britain and Ireland. Similar catalogues exist for South Africa, Canada and the United States; also, no doubt for other countries.

The cost of preparing such a catalogue for the chief Indian libraries would be but a fraction of the cost of a new central library and the result would, I suggest, be of at least equal value to Indian science though it would not, of course, fulfil the same functions. Indeed, even if a central library were eventually instituted the need for such a catalogue would still exist. It would be interesting to know how many librarians of existing libraries would be willing to co-operate in this scheme.

A catalogue of this nature to be of greatest use would need to be brought up-to-date periodically—say, once in every five years.

FORBES W. SHARPLEY.
Department of Engineering,
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Dhanbad,
*June 12, 1934.*

## 'Barren-Sterile'—A New Mutant in Rice and its Inheritance.

AS far as the writers are aware the mutant described in this note does not seem to have been recorded in rice, previously. However, an almost similar case was described by C. M. Woodworth in maize.[3]

In the 1932-33 paddy season, the junior writer in going through the selections from Muthusamba, a variety got from Cuddalore in 1931, noticed that out of 92 single plants grown separately, one lot No. 4900 was found to throw out a fairly large number of plants with leafy shoots, in the place of earheads (Fig. 1). The actual counts showed 148 normal and 38 barren-sterile plants in

[1] Perkin, *J.C.S.*, 1894, **65**, 578.
[2] *Current Science*, 1933, **1**, 335.
[3] *J. Heredity*, 1926.

this lot suggestive of a wide 3 : 1 ratio, and the mutating character as a recessive. As the numbers indicated the possibility of this character as a Mendelian phenomenon, it was decided to carry forward all the normal (ear-bearing) plants for growing as $F_3$'s for

**Fig. 1.**

Photograph showing the ear-bearing and mutant plants.

confirmation. The barren-sterile plants, for obvious reasons, could not be carried forward to give another generation.

Accordingly, 142 normal looking plants were grown as $F_3$'s during 1933-34 season and out of these 58 bred pure for the normal ear-bearing character and the remaining 84 segregated.

| | Segregating Families 84 | Pure Families 58 | |
|---|---|---|---|
| Expected on 2 : 1 ratio | 95·7 | 47·3 | $\frac{\text{Dev.}}{\text{S.E.}}=2\cdot0$ |

| | Normal or ear-bearing plants | Barren-sterile plants | Dev. | $\frac{\text{Dev.}}{\text{S.E.}}$ |
|---|---|---|---|---|
| Total of 84 segregating families | 7,861 | 2,195 | .. | .. |
| Calculated 3 : 1 | 7,542 | 2,514 | 319 | 7·3 |

Though the ratio given is not a very good 3 : 1 the figures undoubtedly indicate that the mutating character is a simple recessive to the normal.

The other parts of the plants that have been more or less profoundly affected by this mutation are the internodes, the leaf blades, number of tillers, and height of plants. It is found that the mutant plants, without exception, in all the families studied, have about twice the number of internodes than the normal plants and that there is very much less variation in lengths of successive internodes in the mutant than in the normal plant (Fig. 2). The mutant plants have leaf blades very much reduced in length. Regarding height and tillering,

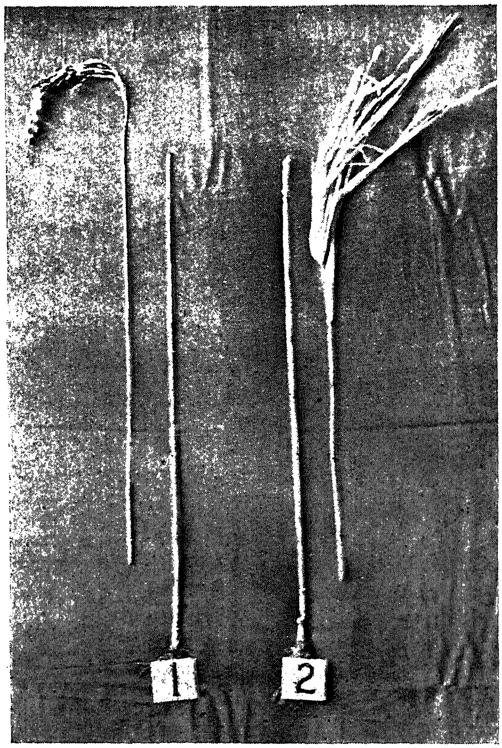



**Fig. 2.**

Photograph to show the differences in internode length and number between : (1) ear-bearing, and (2) the barren plants.

it is found that the normal plants are taller and have more tillers than the barren-sterile plants.

*Probable Origin of the Mutation.*—The mutation under discussion is in all probability a gene mutation and might have occurred either in the sexual cells or in the somatic cells early in the ontogeny of the plant. And this gene seems to have been responsible for barrenness variations in number of internodes and their lengths, in number of tillers, in leaf blade lengths, and in heights of plants, as it is more inconceivable that each of these characters were

governed by a separate gene closely linked in the chromosome and that simultaneous mutation of every one of these took place as a single step. Further, no cross-overs were noted in any of the 142 families studied.

A detailed account of this mutant will be published elsewhere.

M. ANANDAN.
V. KRISHNASWAMI.
Agricultural Research Station,
Aduturai,
*June 25, 1934.*

## The Theory of Liquids.

IN a paper shortly to appear in the *Indian Journal of Physics*, the author has discussed a theory which considers a liquid as being composed of molecules, each associated with a spherical space, of which the diameter is given by the formula for the close-packing of spheres, namely,

$$\sigma_T = (1\cdot 32 \times 10^{-8}) \sqrt[3]{V_T} \quad \ldots (1)$$

This diameter is the average distance of closest approach of molecular centres; it is the distance from the centre of a molecule within which on an average there will be no molecular centres, and outside of which on an average, there will be uniform distribution of molecular centres. Some molecules will approach more closely and there is nothing to prevent slow diffusion of molecules through the liquid. The average effect, however, is that of closely packed spheres. It is assumed that the molecules attract one another with a force given by $\mu/r^m$ where $r$ is the distance between two molecules; $\mu$ is independent of temperature, but $\sigma$ as will be seen from (1) depends on it; the space kept clear around a molecular centre increases as its thermal motion increases.

The theory has now been extended to molecules which attract with the force given above and repel with a force given by $\lambda/r^n$. The following formulæ have been deduced :—

$$\gamma = \frac{\mu}{1\cdot 31(m-5)\sigma^{m+1}} - \frac{\lambda}{1\cdot 31(n-5)\sigma^{n+1}} \quad \ldots (2)$$

$$L_i = 4\cdot 22 \times 10^{16} \left[\frac{\mu}{(m-4)\sigma^{m-1}}\left(1+\frac{T(m-4)\alpha}{3}\right) - \frac{\lambda}{(n-4)\sigma^{n-1}}\left(1+\frac{T(n-4)\alpha}{3}\right)\right] \text{cals.} \quad \ldots (3)$$

where $\gamma$ is the surface tension, $L_i$ is the molecular internal heat of vapourisation, and $\alpha$ is the coefficient of thermal expansion. These equations are to be applied to temperatures of low vapour pressure only.

Lennard-Jones[1] has shown that from the second virial coefficient of a gas it is possible to deduce an array of values of $m$ and $n$. Table 1 shows values of $m$ and $n$, and of the corresponding values of $\mu$ and $\lambda$ deduced from the values of the virial coefficients of five gases. Tables 2 and 3 show the results of the insertion of these values in (2) and (3) respectively. It will be seen that values which satisfy the virial coefficient in the gaseous state give, when inserted in (2) and (3), values which agree with experimental observations for the liquid state.

It may be noted that the Schrödinger equation indicates that helium atoms attract one another with a force varying as the inverse 7th power of the distance and that the force constant lies between 7 and $9 \times 10^{-60}$. The value of $n$ for helium here used is close to that indicated by the viscosity of helium in the gaseous state.[2]

TABLE 1.
*Force Constants derived from the Equation of State.*

| Substance | $n$ | $m$ | $\lambda$ | $\mu$ |
|---|---|---|---|---|
| He | $14\frac{1}{3}$ | 7 | $2\cdot 41 \times 10^{-115}$ | $5\cdot 77 \times 10^{-60}$ |
| $H_2$ | $14\frac{1}{3}$ | 8 | $6\cdot 65 \times 10^{-114}$ | $2\cdot 33 \times 10^{-66}$ |
| Ne | 25 | 7 | $1\cdot 93 \times 10^{-195}$ | $2\cdot 55 \times 10^{-59}$ |
| Ar | 31 | 8 | $1\cdot 30 \times 10^{-237}$ | $1\cdot 41 \times 10^{-65}$ |
| $N_2$ | 31 | 8 | $1\cdot 52 \times 10^{-236}$ | $2\cdot 02 \times 10^{-65}$ |

TABLE 2.
*Surface Tension.*

| Substance | T | $\sigma \times 10^8$ | $\gamma$ calc. (2) | $\gamma$ obs. |
|---|---|---|---|---|
| He | 2·5 | 4·02 | 0·32 | 0·30 |
| $H_2$ | 20·0 | 4·05 | 1·9 | 2·0 |
| Ne | 24·7 | 3·38 | 5·7 | 5·6 |
| Ar | 90·0 | 4·07 | 11·7 | 11·9 |
| $N_2$ | 75·0 | 4·34 | 9·4 | 9·4 |

[1] Lennard-Jones, *Statistical Mechanics*, by R. H. Fowler, Chap. X, 1929.

[2] Lennard-Jones, *Proc. Roy, Soc.*, 1925, **107**, 165.

TABLE 3.

*Internal Latent Heat of Vapourisation (cals.).*

| Substance | T | $\sigma \times 10^8$ | $a$ | $L_i$ calc. (3) | $L_i$ obs. |
|---|---|---|---|---|---|
| He | 2·3 | 4·00 | 0? | 19·4 | 17·6 |
| $H_2$ | 20·0 | 4·05 | ·014 | 169 | 177 |
| Ar | 87·1 | 4·05 | ·0046 | 1280 | 1326 |
| $N_2$ | 63·1 | 4·23 | ·0048 | 1230 | 1330 |

T. S. WHEELER.

Chemical Department,
Royal Institute of Science,
Bombay,
*June, 1934.*

## Efficiency of the Open Pan System of Making White Sugar.

IN these days of manufacturing sugar with the help of all modern appliances, still there are persons who think it worth while trying to improve the open pan system of manufacturing sugar.

The Mysore Department of Agriculture has done a lot of work in this direction during the years 1904-05 and 1906-07 and published the results obtained in the reports of the Agricultural Chemist for these years. The efficiency of the process on a commercial scale was tested on a private estate in 1911, and a summary of the results obtained was published.[1] Recently Sethi and Sarkar have published a note[2] on the single pan method of manufacturing 'Khandsari' sugar.

While the work was conducted on a commercial scale in 1911, a total quantity of 25,550 lbs. of juice were boiled and 2168 lbs. of sugar were recovered from it. Calculated on the quantity of sucrose contained in juice only 48·2% of it was recovered as sugar. Just for comparison, the proprietor of the estate boiled 11,850 lbs. of juice in his own pans and obtained 2,419 lbs. of jaggery from it. The weight of jaggery obtained worked out to 20·4% on the weight of juice boiled while the recovery as sugar was only 8·8%, *i.e.*, less than 45% of the weight of jaggery. In the process followed by Sethi and Sarkar the recovery of sugar from juice is only 8·28% against a recovery of 8·8% by the Mysore process. Calculating the recovery on the amount of sucrose contained in juice the recovery by the Mysore process was 48·2% against 46·8% by Sethi and Sarkar.

It is worth while considering whether sugar making by the open pan system will pay at all in competition with modern sugar factories working in India itself. With improved methods of milling and manufacture, modern sugar factories can and do surely recover much more sugar from cane than the open pan system ever can with the milling and boiling appliances at disposal.

Whether it is worth while spending further time and money on trying to improve the open pan system is a matter for serious consideration.

B. N. IYENGAR.

Department of Agriculture,
Mysore, Bangalore,
*July 3, 1934.*

[1] *Journ. Mys. Agric. & Exptl. Union*, 1924, **5**, No. 3.

[2] *Agriculture and Live-Stock in India*, **3**, Part V.

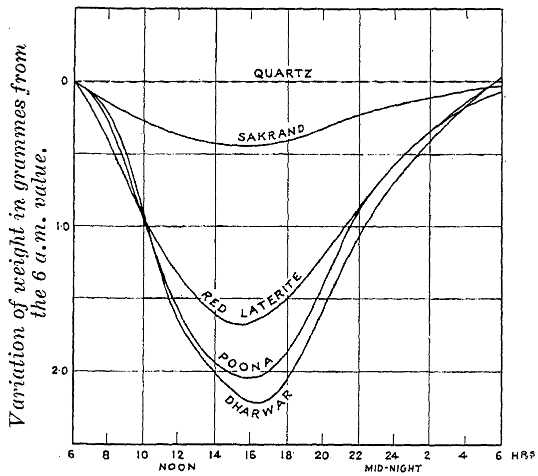
## The Variation of Moisture in the Surface Layer of the Soil in Relation to the Diurnal Variation of Meteorological Factors.

IN a recent note[3] one of us referred to the decrease in the pressure of water vapour with height above bare soil during day and the reverse phenomenon at night. These effects were observed daily at Poona during the clear season, November to April, when the surface layer of the soil is dry and contains only hygroscopic moisture. Experiments with samples of the surface soil exposed under natural conditions (in the open) showed that there was appreciable loss of weight by evaporation during the day and that most of the moisture lost by day was regained from the atmosphere during the night. These results readily explain the humidity observations, for, during the day, owing to insolation and consequent rise in temperature, the soil surface gives up moisture to the atmosphere, whereas during the night it absorbs moisture from the air layers above it and thus reduces the vapour pressure in these layers.

Soil samples from a few other centres were next exposed in a similar manner and their weights determined at two-hourly intervals. The weights of the soils were of the order of 60 grammes, the area of cross-section of the vessels used being 30 square centimetres. Observations of air temperature, humidity, soil temperatures, wind

[3] *Curr. Sci.*, 1934, **2**, 445.

velocity and intensity of radiation from the sun and sky received by a horizontal surface were also made simultaneously. The figure shows the variation in the weights of




*Time.*

the different samples from 6 A.M. of 1-6-1934, to 6 A.M. of 2-6-1934, the variations being expressed with reference to the weight of each sample at 6 A.M. It is interesting to note the very high amplitudes of the evaporation during day and the absorption during night in the case of soils from Poona and Dharwar. Soil from Sakrand showed a moderate variation. The weight of each sample is maximum at the minimum temperature epoch (about 6 A.M.) and minimum at the maximum temperature epoch (about 2 P.M.). A sample of quartz powder, however, showed hardly any variation. The responses of different soils to the diurnal variation of meteorological factors appear to offer an interesting method of studying the hygroscopic properties of different soils and their influence on the micro-climate.

Further work with different soils is in hand. The results obtained so far are being discussed fully elsewhere.

L. A. RAMDAS.
M. S. KATTI.

Agricultural Meteorology Branch,
Meteorological Office, Poona,
*July 6, 1934.*

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## Refractive Index of Thin Films of Potassium.

IN recent papers, Zener and Kronig have given a quantitative explanation of the remarkable optical properties of alkali metals in the ultra-violet observed by Wood[1] In particular, Kronig[2] has calculated the refractive index of potassium for different wave-lengths, and compared with the values deduced from Wood's measurements on the change of amplitude and phase on reflection from thin films of potassium. Though the calculated values are of the same order of magnitude as Wood's observed values, the numerical agreement is far from satisfactory; the calculated values being consistently lower, being usually about one-tenth to one-half.

The purpose of the present note is to suggest a probable explanation for this discrepancy. The experimental values of Wood refer to a thin film of material, whose thickness is of the order of the wave-length of light, whereas the computations of Kronig refer to an extended medium. It is well known from measurements on the conductivity of thin metallic films that as their thickness is reduced they show an *abnormal* increase in resistance. This has been explained recently by A. Jagersberger[3] in the following manner. As the thickness of the film becomes so small that it is comparable with the electronic mean free path, the effect is as though there is a decrease in the number of free electrons which are responsible for conduction, and hence the abnormal increase in resistance. The discrepancies between Kronig's calculated values which refer to an extended medium, and Wood's experimental values which refer to thin films may probably be attributed to the same cause. On calculation, we find that a fit between the above calculated and experimental values can be obtained if the "effective" number of free electrons per c.c. in Wood's thin potassium films are taken to be about 50% of the actual number. This is of the same order of magnitude as is necessary to explain the anomalous resistances of thin films.

From this point of view, measurements on the resistances of thin films of potassium obtained by Wood's method would be very desirable.

B. MUKHOPADHYAY.

210, Bowbazaar Street,
Calcutta,
*July 12, 1934.*

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1 *Phys. Rev.*, 1933, **44**, 353.
2 *Nature*, 1934, **133**, 211.
3 *Zeit. f. Physik.*, 1934, **87**, 513.

## Absorption Spectra of Single Crystals of Polynuclear Hydrocarbons.

THE absorption spectra of single crystals of a number of polynuclear hydrocarbons have been studied by us using incident linearly polarised light. Among the crystals studied are anthracene, phenanthrene, 1, 2-benzophenanthrene, 1, 2, 5, 6-dibenzanthracene, fluorene, fluoranthene and pyrene, for which the orientations of the molecular

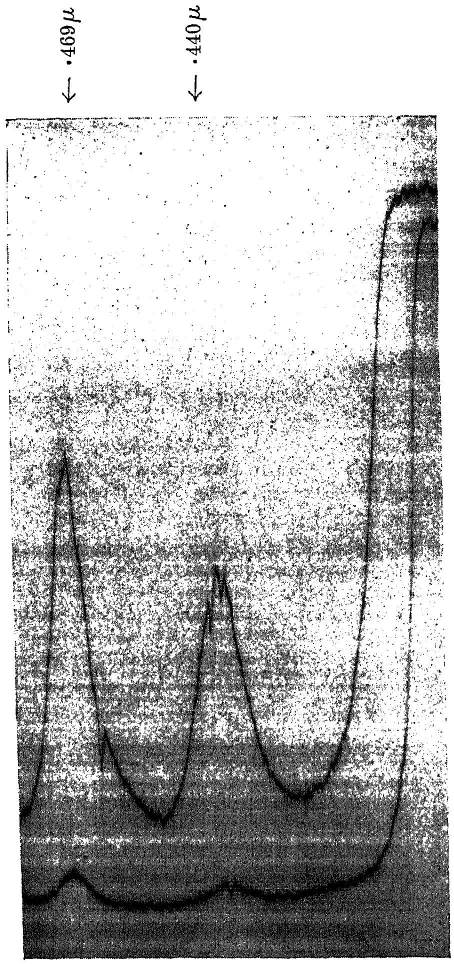


**Fig. 1.**

benzene planes in the crystal lattice are known either from X-ray analysis or from the magnetic measurements on the crystals. In all cases, it is found that *the absorption of the crystal is much more intense when the incident light vibrations are parallel to the plane of the benzene rings in the molecules than when the vibrations are along the normal to the benzene planes.*

As an example, we may take the case of 1, 2, 5, 6-dibenzanthracene. It crystallises in the monoclinic system in the form of thin flakes parallel to the *c* (001) plane. Recent X-ray measurements on this crystal by Iball and Robertson, and magnetic measurements by Banerjee in this laboratory, show that the benzene rings in the molecules of the unit cell are nearly parallel to the *b* (010) plane, and that the long axes of the molecules are nearly perpendicular to the

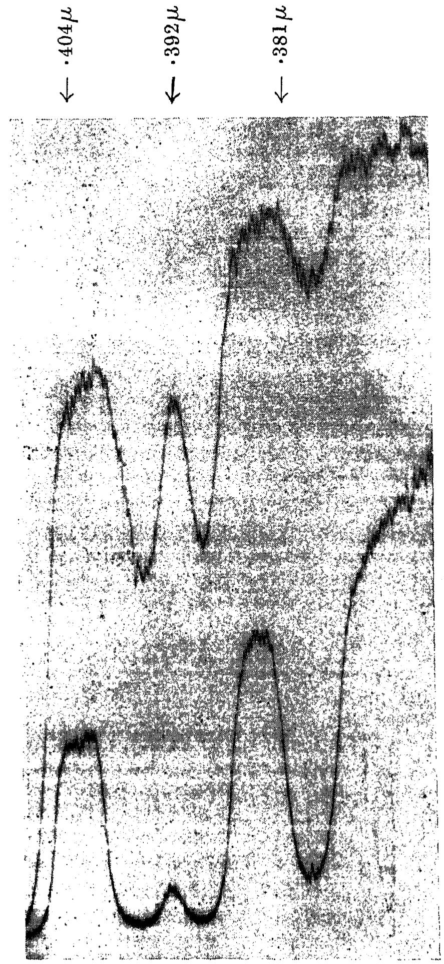


**Fig. 2.**

*a* axis. Therefore, one of the extinction-directions in the plane of the crystal flake, namely the *a* axis, would correspond predominantly to vibrations in the plane of the benzene rings along the width of the molecules, while the other extinction-direction, namely, that along the *b* axis, would correspond predominantly to vibrations perpendicular to the plane of the benzene rings.

Using one such crystal flake of 1, 2, 5, 6-dibenzanthracene and allowing linearly polarised white light to be incident normally on the flake, its absorption spectra for the above two principal vibrations have been studied by us. Fig. 1 gives a microphotometric record of the absorption spectra in the visible region, the upper curve corresponding to vibrations along the *a* axis, and the lower to vibrations along the *b* axis. It is remarkable that whereas the absorption bands appear prominently when the vibrations are along the *a* axis, they are quite feeble for vibrations along the *b* axis. Thus, these absorptions are practically confined to vibrations in the plane of the benzene rings, the vibrations along the normal to the plane of the benzene rings being almost freely transmitted.

In Fig. 2 are reproduced the microphotometric records (on a different scale from that of Fig. 1) of these two principal absorptions for the *ultra-violet* region. The upper curve corresponds as before to vibrations along the *a* axis, and the lower curve to vibrations along the *b* axis. Here again, the polarisation of the absorption bands is evident.

The absorption by napthalene, 1, 4-napthoquinone and *p*-benzoquinone also show a similar striking dependence on the direction of the light vibration with reference to the molecular planes.

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P. K. SESHAN.

210, Bowbazaar Street,
Calcutta,
*July 12, 1934.*

## Insect Transmission of Spike-Disease.

In a recent issue of the *Indian Forester*[1] there have appeared some further communications on this highly controversial and vexed question. As the subject is one of much scientific as well as practical interest, it has been considered desirable to review the present position with special reference to its mere practical bearings.

In October 1933, Dover[2] announced that *Moonia albimaculata* had three positive transmissions of spike-disease. The resulting symptoms were 'inseparable' from those of typically spiked plants on morphological, biochemical and cytological grounds. The author admitted that the transmissibility of those symptoms by grafting had still to be established.

Sreenivasaya,[3] who carried out the grafting tests, failed, however, to obtain any transmission of symptoms to plants grafted with material derived from the *Moonia*-infected plants. He further states that "the three plants alleged to be diseased only represented a stunted condition which was brought on by an impoverished soil, want of a vigorous host and probably aggravated by insect-feeding"; they "after careful nursing with fresh soil and host, have since turned completely healthy."

In his reply to Sreenivasaya's note Dover[4] does not concur with the claims of his colleague that the *Moonia* plants became healthy and relates his experience of having seen healthier-looking plants recorded as "genuinely spiked" and of markedly reducing "spike-like faces of disease sandal plants" by pruning, nursing or growing in shade.

Literature on the spike-disease of sandal records several instances where such controversial differences of opinion have often been expressed. (See *Proc. Conference on Spike-Disease of Sandal*, 1917.) In fact, the "spike-like new flush bursting in response to certain types of injury to the sandal plant, like fire, has been mistaken for spike." "With regard to the appearance of spike-like growth on trees badly burnt as noted by Mr. Hole, both Mr. H. S. Narayana Rao and Rao Sahib Rama Rao considered that this should be worked upon as a temporary reaction and that later the growth would once more become normal" (*Ibid.*, p. 6). Hearsey referring to the idiosyncracies of sandal, invites attention (*Ibid.*, p. 31) to "the small leafed tree which is invariably found on dry soil in exposed localities, leading a novice to imagine that the tree was spiked". Chatterjee[5] in the course of his extensive

[1] *Indian Forester*, 1934, **60**, 492.
[2] *Ibid.*, 1933, **59**, 695.
[3] *Nature*, 1934, **133**, 382.
[4] *Indian Forester*, 1934, **60**, 505.
[5] *Investigations on Spike-Disease of Sandal*, **1932**, **5**, **12**.

experiments with "the suspected vectors", *M. variabilis* (*albimaculata*), *P. uniformis* and *Sarmia* sp. (?), observed "distinct shortening of internodes and leaves and also clustering of leaves" in his experiments with *P. uniformis*, but all these trees developed healthy flush later.

The few extracts given above illustrate that certain types of growth present "faces" which may sometimes be mistaken for spike, and emphasise the need for developing an "objective method" of diagnosing the disease, which would be helpful in deciding doubtful cases of growth. Its importance appears to have been fully realised by both the research organisations: (1) the Department of Agriculture, Mysore, and (2) the Indian Institute of Science. Narasimhan of the Mysore Group has provided a cytological technique by which one can diagnose spike while a grafting technique is offered by the Institute workers. The latter technique which is simpler has been applied successfully and extensively for deciding doubtful specimens.

Dover remarks that grafting experiments only yield "a type of evidence which is considered inconclusive when applied to the results of insect transmission studies"[6] and his contention is supported by the Editorial review which asserts that "the results of insect transmission experiments cannot now be proved or otherwise by grafting experiments."[7] It is rather difficult to appreciate the force of this argument, if one remembers that the grafting technique is one that has proved successful in diagnosing cases of spike naturally transmitted by vectors operating in forests. Since the main objective of the entomologist is to transmit spike through the agency of viruliferous vectors, the vector-fed plant, if it should be pronounced to be typically spiked, should answer the grafting test just as much as a spiked plant (grafted with material derived from a naturally diseased plant) does stand a similar test.

It may be argued that in the case of the *Moonia*-fed spiked plants, the dosage was insufficient, that the disease produced was not virulent, and that the vector in question transmitted only a single component of the virus complex which has possibly two or three. But it only serves to establish the fact that the insect transmission has not been the success, as it was announced to be some time ago.[8] It should be, however, admitted that the large number of negative experiments conducted by Chatterjee and Dover are very illuminating, but it is unfortunate that in spite of the independent efforts of the Mysore Agricultural Department and the Forest Research Institute, Dehra Dun, the natural transmission of spike should still remain obscure. We cordially endorse the opinion of the Editor of the *Indian Forester* that "the only profitable course in future is to repeat them extensively with such modifications of technique as are required by the possibly complex nature of the spike virus and the dependence of virulent infection or such factors as dosage or dual vectors."

[6] *Indian Forester*, 1934, **60**, 505.

[7] *Ibid.*, 1934, **60**, 492.

[8] Dover, *Nature*, 1933, **132**, 592.

# The Geology of the Krol Belt.

DURING the past ten years or so considerable advance has been made in our knowledge of the geology of the Himalaya, which has served to show that the structure of these mountains is more complicated than had hitherto been thought. Mr. Auden in a recent publication[1] has dealt with the geology of this mountain range. In the reviewer's opinion it must be regarded as a most important contribution to Himalayan geology, based as it is on detailed mapping and acute observations. The area described is a long narrow belt running E.S.E. from Solon on the Kalka-Simla railway, along the south-west side of the Giri valley, and across the Tons river to the southern part of the Chakrata district. On its north-east side is the area of more highly metamorphosed rocks mapped by Pilgrim and West; on its south-west side is the belt of Tertiary rocks forming the southern edge of the Himalaya.

Broadly speaking, Mr. Auden regards the Krol belt as a thrust mass of Jaunsar-Blaini-Krol-Tal rocks resting on a floor of Simla slates and Tertiary rocks. Separating these two groups is the Krol thrust, which is itself folded. (The well-known outcrops of Subathu beds near Solon are thus regarded as belonging to the underlying group of beds, below the Krol thrust.) The details of the geology, however, are exceedingly complicated, as a glance at the map accompanying the paper will help to show. In addition to the general description of the area itself, many problems which have a bearing on the geology of adjacent tracts are dealt with in a forceful and penetrating way. Brief reference may be made to some of these.

It has lately become increasingly clear to those working in the Himalaya that the importance of the well-known 'Main Boundary fault' of Medlicott and Middlemiss, separating the Siwaliks from the older Tertiary rocks, has been overrated; and Mr. Auden crystallises this change of opinion in a well-reasoned statement, from which the following may be quoted:

"It appears to the writer that the conception of a 'Main Boundary fault', and hence of a basal thrust-plane to the Himalaya, has been carried too far. It arose at a time when the faults were thought actually to mark the successive limits of sedimentation against the uprising Himalaya and when the structure of the pre-Tertiary rocks had not been examined in detail. Recent work by Pilgrim, Wadia, West and the writer has shown the number of thrusts that actually exist in these pre-Tertiary rocks. Some of these cannot be considered minor structures, comparable solely with the minor thrusts, as distinct from the major thrusts, of the North-West Highlands. The Chail thrust of Mr. West is of premier importance. In the Himalaya, as in the Alps, it would appear impossible to regard any single dislocation or *nappe* as having borne the whole burden of the advance upon the foreland."

An illuminating suggestion put forward by Mr. Auden is that the true Blaini beds which underlie a normal Infra-Krol-Krol succession are distinct from beds mapped elsewhere as Blaini, *e.g.*, at Simla (which may come as a shock to some). These latter he would correlate with the Mandhali beds of Chakrata, suggesting that there were two periods of glaciation (or whatever the conditions were which gave rise to those peculiar beds), one at the base of the Jaunsar series and the other below the Krol series. And while this suggestion has a good deal to commend it, explaining a number of difficulties, it is one which must for the time being be regarded as non-proven. An alternative explanation is that Oldham included under the name Mandhali two distinct sets of rocks, the true Mandhali beds at Mandhali village in north Chakrata, which may be in part identical with the Blaini at Solon and Simla; and other beds in South Chakrata, those mapped by Mr. Auden, which are basal Jaunsars.

A good deal of emphasis is laid by Mr. Auden on the effect of varying degrees of metamorphism upon rocks, more especially the bearing it has upon correlation. Apparently the grade of metamorphism displayed by the rocks of the Krol belt is always of an epi-type, in which shearing stress and low temperature have been the main factors. But the degree of metamorphism to which the rocks have been subjected varies considerably from place to place, and frequently makes the correlation of the rocks a matter of great difficulty. Consequently the author lays emphasis on the unsoundness of placing too much reliance on metamorphic grade in problems of correlation. He goes even further, however, and suggests that the *meso*-type of metamorphism displayed by the Jutogh series in the country north-east of the Krol belt may be a local phenomenon related to the intrusion of the granite, and is not by itself to be

[1] *Rec. Geol. Sur. Ind.*, 1934, **67**, Part 4, pp. 357-454.

regarded as evidence in favour of those rocks being older than the rocks of the Krol belt.

As regards the time of the intrusion of the gneissose granite which is found in the Jutogh series, and similar granites elsewhere (the Central Himalayan gneiss of Stoliczka) Pilgrim and West, while refraining from expressing any definite opinion, except that it was probably pre-Chail in age and possibly Archæan, rejected McMahon's view that the intrusion took place during the Tertiary at the time of the upheaval of the Himalayas. Mr. Auden goes further, and puts forward reasons for supposing the intrusion to have taken place during the Palæozoic, suggesting that it occurred in connection with certain crust movements which he suggests took place in pre-Krol times, along a line coincident with the line of the old Aravalli mountains if continued northwards into the Himalayas.

Other aspects of the geology, mostly relating to the lithology of the rocks, are described in detail. But enough has been said to show the importance of this paper in throwing further light on the structure of the Himalaya. It is accompanied by a map of great beauty, which does credit alike to the author who made it, and to the Survey of India who printed it.

W.

# Research Notes.

## Singular Solutions of Ordinary Differential Equations of the Second Order.

The methods of obtaining the Singular Solutions, which are applicable when a given differential equation or one of its first integrals involves irrational or transcendental expressions, are described by Srinivasiengar in an important paper published in the *Jubilee Memorial Volume* (Vol. 20) of the Indian Mathematical Society.

In Part II of the same paper the author has discussed a number of topics of interest. Several illustrations of differential equations which possess, what the author calls *incomplete primitives*, are given and the readers are cautioned against calling the *residual* primitive as singular solutions. The author disagrees with the existing theory about Singular Solutions of the second order, and explains how *any singular solution of the equation* $w(x, y, y')=0$ *will satisfy the original equation* $F(x, y, y', y'')=0$ *in a large number of cases* ($w=0$ being the equation giving Singular Solutions of the first order). A new method of obtaining the osculants of the system $f(x, y, a, b)=0$ is also given.

## Envelopes of Systems of Surfaces.

In a paper published in the *Tohoku Mathematical Journal* (**39**, Part I) Srinivasiengar has discussed the methods of obtaining the envelopes of singly infinite and doubly infinite systems of surfaces, when the equations of these systems may contain irrational or transcendental expressions. The results centre round the following theorem, which is proved in the paper:

*If one or more of the first partial derivatives of* $f(x, y, z)$ *become infinite in virtue of* $\phi(x, y, z)=0$, *the two surfaces* $f=0$, $\phi=0$ *touch each other all along their curve of intersection* (except in very special cases).

Among the corollaries of this result, the following may be particularly mentioned:

*If* $E=0$ *denotes the envelope of the first species of the system of surfaces* $u(x, y, z)=a$, *it will also be an envelope of the first species of the system* $\phi(u, v)=a$, *where* $\phi$ *is any holomorphic function of* $u$ *and* $v$, *and where none of the first partial derivatives of* $v$ *becomes infinite in virtue of* $E=0$.

## "Showers" of Positive and Negative Electrons.

Perhaps the most beautiful phenomenon revealed by the application of Wilson's cloud chamber method to the study of cosmic radiation is the occurrence of "showers" of positive and negative electrons apparently emanating from a point in the neighbourhood of the cloud chamber. In the *Proc. Roy. Soc.* for May, C. W. Gilbert describes the results of his experiments on the production of these showers. The investigations were carried out by him in Switzerland at three different heights above sea-level—3500 metres (Jungfranjoch), 2300 metres (Eigergletscher) and 500 metres (Zürich). Using three Geiger-Muller counters, he investigated the simultaneous coincidences in the three counters caused by the presence

of varying thicknesses of lead screen placed above and below the counters. He finds that with increase of height, the number of showers increases at about the same rate as the intensity of general cosmic radiation. From a comparison of the absorption of the shower-producing radiation and of the general cosmic radiation, Gilbert concludes that the two are not identical. There are thus at least three types of rays associated with cosmic radiation: (1) primary radiation in all probability consisting of charged particles with excess of positive and having an energy of the order of $10^{10}$ electron-volts as shown by the variation of cosmic ray intensity with latitude, (2) shower-producing radiation of unknown kind, perhaps of the $\nu$-ray type, and (3) shower particles consisting of positive and negative electrons with energies of the order of $10^9$ electron-volts and originating simultaneously in the field of the nucleus of atoms.

K. R. R.

### A High Intensity Mass-Spectrometer.

THE isolation of isotopes in the case of elements available in a gaseous form has been achieved by Hertz and his method has been described in these columns (*Curr. Sci.*, 1932, **1**, 173). The separation of the isotopes of solid elements, however, has not been a success so far. W. R. Smythe, L. H. Rubaugh and S. S. West (*Phys. Rev.*, 1934, **45**, 724) now describe a form of mass-spectrometer designed by them to achieve the above object. The essential part of the instrument is a new form of pole piece which serves as a magnetic lens. Both boundaries of either pole piece are formed by two circles passing through the origin of coordinates, one of them having its centre on the Y-axis (which is parallel to the original direction of motion of the positive rays) at the focal point C, while the centre of the other is at a distance $r$ to the right of C, where $r$ is the radius of curvature of the trajectories in the field. In order to have an intense parallel beam of positive rays, a concave cylindrical electrode, machined out of an iron block and having only some parts covered with emitting material, was used as the source of the rays and a slit with bevelled edges was used, its width and level as well as its distance from the emitter being adjusted to be suitable to the curvature of the electrode. Two focussing bars were also used to correct any errors in these adjustments.

The heating elements consisted of 35-mil molybdenum wires wound on 8 mm. Stupekoff tubing passed through two large holes in the source block which was surrounded by a water-jacketed copper box at the same potential. The source could attain 1450° K when the iron evaporated noticeably but without permanent injury, and was found suitable for several Kunsman catalyst alkali metal emitters. The accelerating potential was taken from a 6000 volt, 10 Kw. D.C. generator which was found to be very steady.

The receiving arrangement was a vacuum-tight cylindrical box with two slits; the position and width (1 mm.) were adjusted so as to coincide with the focus regions of the two isotopes of potassium which was the metal studied. The collectors were placed behind the slits. With an ion current of 0·1 milliamp., about a milligram of $K_{39}$ was obtained in 7 hours. Samples of $K_{41}$ for radioactive work are reported to be under preparation.

### Negative Protons and Nuclear Structure.

ARGUING from the discovery of the positive counterpart of the electron, *viz.* the positron, and from the fact noted by Williams (*Phys. Rev.*, 1934, **45**, 729) that some of the negative particles present in cosmic radiation correspond to a protonic mass, Gamow (*Phys. Rev.*, 1934, **45**, 728) infers that there may be a number of negative protons amongst the constituents of nuclei, the neutron being then considered as made up of a positive proton and a negative electron or a negative proton and a positive electron. Consideration of the stability of nuclei on lines similar to those adopted by Heisenberg leads to the conclusion that the exchange forces between positive and negative protons form a repulsive system. Some modifications in the previous theory necessitated by the introduction of negative protons are expected to bring the calculation of limits of stability of nuclei into better agreement with experiment. Another consequence of the new idea is the possibility of existence of isomeric nuclei, *i.e.*, nuclei of the same charge and mass but of different constitution. The radioactive element UZ (found by Hahn) is regarded as an isomer of $UX_2$, this view providing an explanation for the fact that $UX_1$ disintegrates into $UX_2$ or UZ with a $\beta$-transformation although $UX_2$ has

no tendency to change into UZ, but both disintegrate to form UII.

### Tooth Structure and Vitamin-C Deficiency.

WILFRED FISH AND LESLIE HARRIS in a recent contribution (*Phil. Trans. Roy. Soc. Lond.*, 1934, **B. 502,** 489) have presented the results of their investigations on the teeth and jaws of guinea-pigs suffering from acute full scurvy, chronic sub-scurvy, developing scurvy, curing scurvy, and complications due to other dietary deficiencies. The authors have given a new interpretation of the dental abnormalities seen in vitamin C deficiency, the "Pulptone" theory being rejected and the difference between the appearance of the tooth in scurvy and sub-scurvy accounted for. A theory is advanced as to the mode of action of vitamin C, which is regarded as a primary necessity for maintaining the functional activity of certain types of cells, including odontoblasts, osheoblasts, ameloblasts, etc.; other effects of vitamin C deficiency are physiological sequetæ of this primary action. Attention is also directed to the practical importance of the disorders in the enamel and cementum, overlooked by past workers.

### The Segmentation and Chondrification of the Skull of the Duck.

IN an exceedingly interesting paper (*Phil. Trans. Lond.*, 1934, **B. 502**) Barrington and de Beer have described the segmentation and chondrification of the skull of the duck. The object of this paper has been to clarify some obstruse points in the development of the skull. The authors have attempted successfully to explain why the planum sphenolaterale separates the first and second branches of the V-nerve and why the 9th and 10th nerves are separated by a cartilege and also the abnormal passage of the olfactory nerves and carotid arteries and the homology of the turbinals. Barrington describing the segmentation, points out that the skull consists of 9½ segments of which 6½ are metotic. The part on the chondrification of the skull is contributed by de Beer. The author very clearly describes the occipito-atlantic joint in the vertebrates generally and notes that the formation of the condyle in squamata (which resembles the mammals) is different from that of Crocodile, Chelonia and birds. A reference to the occurrence of the 'proatlas' arch is also made. At the end, the phylogeny of the amniota is briefly described from the view-point of chondrification. It is said that a stock in the Amphibia with an inter-segmental occipito-atlantic joint gave rise to Sauropsidan and Theropsidan branches. In the latter branch the inter-segmental type of joint persisted while in Chelonia, Crocodalia and Squamata alone the joint became intrasegmental.

### Endocranial Cast of Sinanthropus.

A NOTABLE contribution to our knowledge of the remarkable fossil man of China is made by J. L. Shellshear and G. Elliot Smith (*Phil. Trans. Roy. Soc.*, **B. 503,** pp. 469-487). The endocranial cast of Sinanthropus is perhaps the best preserved of all the fossil men known and lends itself to a comparison with the actual brains of modern men. It is undoubtedly clear from the examination of this cast prepared by Late Prof. Davidson Black that we are dealing here with a remarkably primitive brain. The occipital region is identical with that of the apes and a comparison with the brain cast of Pithecanthropus reveals that Sinanthropus is more primitive and in an earlier stage of evolution. A precocious expansion of the posterior end of the second temporal convolution and the orbital margin of the frontal territory are noticeable. There is again a precocious expansion of the lower parietal area and a pushing forward of the pole of the temporal region. An important peculiarity is the remarkable degree of symmetry between the two cerebral hemispheres, which is a very rare feature in the human brain.

### Differentiation in Basaltic Magmas.

A VERY important paper on "Trends of Differentiation in Basaltic Magmas" is published by W. Q. Kennedy in a recent number of the *American Journal of Science*, 1933, **25,** pp. 239-56) in which certain ideas previously published by the author in his paper on "The Parent Magma of the British Tertiary Province" have been further developed so as to include basaltic rocks in general. As a result of these studies it has been shown that the two main basaltic magma-types—the Olivine-basalt Magma-Type and the Tholeiitic Magma-Type—are both of world-wide distribution and fulfil the conditions of primary magmas.

It is therefore suggested that we must recognise that these two are distinct parent basaltic magmas, each of which has its own independent line of descent. There is no evidence for supposing the existence of a common source for these two basaltic magmas nor is there any reason to infer that either of them is a derivative from the other.

### Crush Conglomerates of Dharwar Age.

IN a recent number of the *Rec. Geo. Sur. Ind.* (**67**, Pt. 4) Dr. M. S. Krishnan has published a short paper on "Some Crush Conglomerates of Dharwar Age from Chota Nagpur and Jubbulpore" in which he has given a petrographic account of some crush conglomerates which he has noticed in the Gangpur State of Bihar and Orissa and in the Jubbulpore District of the Central Provinces, and compared these with the 'autoclastic conglomerates' described elsewhere in India. The author recognises the fact that "the criteria for distinguishing autoclastic from crush conglomerates of sedimentary origin are generally difficult of application in the field where highly folded and metamorphosed sediments are concerned." He is, however, of opinion that practically all the material described by him in the present paper are undoubtedly conglomerates of sedimentary origin, although in some places the sedimentary characters have been obscured by intense shearing and crushing.

## Agricultural Education in India.

By Keshava Sharan Agarwala, M.SC., LL.B.

IN a predominantly agricultural country like India where the vast majority of the population lives on agriculture, the importance of agricultural education cannot be overemphasised. The need for it has been fully realised by the Government of India and the Provincial Governments and much has been done in this direction in recent years in the form of practical demonstration and propaganda on Agricultural farms and by providing facilities for higher education in agriculture. Besides the Agricultural Research Institute at Pusa and the Imperial Institute of Animal Husbandry and Dairying at Bangalore, which provide post-graduate training and research facilities in agricultural science and for which the Government of India is responsible, the provinces have their own agricultural colleges teaching diploma and degree classes. In addition to these agricultural colleges, some of the Indian Universities have also recently instituted B.Sc. courses in agriculture.

The collegiate education in agriculture is no doubt very useful and necessary, but even at the best, only a very small portion of the population can hope to obtain it. Moreover, the graduate coming out of the agricultural college, as a rule, seeks Government or other employment instead of taking up practical farming where he could give the fullest benefit of his advanced education to the country's agriculture. For the rural masses, considering their number as well as their gross illiteracy, what is required is a type of general agricultural education of a school standard and imparted through the vernacular medium of instruction. There should be established agricultural schools all over the country so that the children of the agricultural classes may freely join them after the necessary vernacular education and learn the up-to-date methods of cultivation and the use of new implements, etc., under trained teachers in a course of 3 to 4 years just to suit their practical needs. These schools will provide the country with a set of young men who will take up the cultivation of land according to modern agricultural methods.

There are very few agricultural schools at present in India and there is a definite demand in the country for more schools of this type. Unfortunately, the recommendation of the Royal Commission on Agriculture to the effect that there should be no extension of such schools greatly retarded their growth. Time has, however, amply proved the immense utility of such institutions and the Provincial Governments are also recognising their usefulness. In this connection, it is gratifying to note the decision of the Bombay Government to continue the two farming schools in the presidency, the abolition of which was recommended by the Thomas Reorganisation Committee. The Government have, however, decided to effect economies in the working of these schools. It may be mentioned that in the case of educational institutions, economies are effected either by curtailing their activities by staff reduction or by increasing the fees. None of these methods should be adopted in this case since there is necessity for opening more schools and also for popularising them by fixing the fees as low as possible so as to bring them within the reach of the rural masses.

It might be pleaded that in these days of financial stringency, much attention and money cannot be devoted to agricultural education. It must not, however, be forgotten that the interest of the whole country is at stake in agriculture and that agricultural education is a necessity if the country is to have the fullest benefit of its agricultural industry. Its development will undoubtedly lead to greater prosperity and a bright future. The educational activities about agriculture therefore require extension and should on no account be curtailed.

# Rice Research in Madras.*

By K. Ramiah.

INDIA including Burma occupies a very predominant position with regard to world's production of rice, its share being 33 million tons out of a total of 59 millions. The share of Madras in this is roughly a little over 5 millions. So far as trade in rice is concerned, it is Burma because of its big production and meagre population that figures most prominently. The most important feature of rice cultivation is the profuse water supply it requires. It is grown essentially under swamp conditions throughout the world.

Rice is one of the earliest crops known to man. Regarding its place of origin recent researches have shown that S.-E. Asia, either Indo-China or India, is the original home. In an ancient Chinese work, nearly 5,000 years old, rice is mentioned as one of the principal plants nourishing the country. Ancient Egyptians did not know of rice, nor is it mentioned in the old testament. The Asiatic origin of rice is confirmed by the multifariousness of the varietal material in China, Indo-China and India. Rice got into Europe only by 300 B.C. introduced by Alexander from India. Due to the antiquity and the ages through which it has been in cultivation there is a profusion of varieties. It is stated that there are over 2,000 varieties in Asia alone and the Coimbatore collections that have been gradually accumulating have now come to nearly a 1,000. The characters, both morphological and physiological, in which the varieties differ from each other are extremely varied that it is impossible to adopt a perfect system of classification. The life duration of the plant may vary anything from 90 days up to 8 months and this again is subject to the influence of the locality in which it is grown.

A systematic study of rice begun in Madras in 1914, covers all aspects, genetics, morphology, physiology, agronomy and recently cytology as well. The three well-known methods of crop improvement work have been practised, *viz.*, introduction, selection and hybridisation. Except one or two instances, the question of introduction has not been attended with much success as the question is, to a large extent, dependent upon the particular requirements of particular tracts.

The pure line selection, the main underlying principle of which consists in that the merits of an individual are to be judged by the performance of its progeny, has been very fruitful of results. Already ten strains have been evolved in Coimbatore which are under distribution to the people in different parts of the province. The area under these improved strains can now be safely reckoned in several hundreds of thousand acres. These strains besides giving yield increases varying from 10-20% are also found to possess some useful ancillary characters like good quality rice, high percentage of rice to unhusked grain, resistance to diseases, etc. As an instance of the wide popularity of one of the Coimbatore strains, mention may be made of GEB 24 which is grown practically all over the province. Even in Mysore where it was first introduced in 1924-25, it is now considered the most popular variety occupying 30—40 thousand acres.

The selection work has, however, one important limitation in that we cannot be sure that a strain doing well in one centre under a particular set of agricultural and climatological conditions will behave equally so under a different set of conditions. So the expansion of the Coimbatore work took the shape of the opening of a number of sub-stations, one in each of the important rice tracts of the province, so that the local problems and the local varieties could be tackled there. The first sub-station opened in Aduturai for the Tanjore district, has already issued 11 strains, and at a very modest estimate it can be said that more than half the area of this district is now grown with these improved strains. The second station opened in Maruteru has issued 8 strains suitable for the Kistna and Godavari districts. It is only a question of time before strains are issued from two other stations, one in Pattambi for Malabar, and the other at Berhampore for Ganjam, the two districts which record the poorest rice yields in the province.

Rice plant just like any other organism is influenced by the environment, soil and climate, in which it is grown and hence probably the widely divergent acre yields obtained in the different rice-producing countries of the world. India occupies an unfavourable position with regard to acre yields when compared to countries like Spain, Japan and Italy though among the provinces within India, Madras is definitely the best. That intensive methods of cultivation, manuring and growing of strains all combined, can increase the yields even in Madras has been exemplified in the Coimbatore Central Farm where the average acre yields have been increased to nearly 4,000 lb., nearly double those of 10 years ago.

The next line of improvement is by hybridisation which attempts at synthesising in one variety certain desirable characteristics observed in two or more varieties, by undertaking artificial crossing among them, and picking out from the resulting varying progeny those types showing the desirable combinations. The success of this work depends upon the correct choice of the parents and a knowledge of the genetics of the particular characters sought after. The principle of inheritance is based on the famous "Mendel's Laws". The study of cytology, *i.e.*, the changes in the cell contents, which has made such great progress in the last two decades has had a phenomenal effect on the study of genetics. It was just 25 years ago that a definite connection was actually established between the behaviour of chromosomes, the dark staining minute bodies in the nucleus of the cell, and the laws of heredity. We are indebted to Professor Morgan and his colleagues in America who, with their classical work on the fruit fly, *Drosophila*, have been mainly responsible for this advance now recognised as the "chromosome theory of heredity". His work has led to several important modifications in the "Mendel's Laws", and has given us the conception how two characters in particular instances always go together and occasionally behave independently, known in

* Text of a paper read before the Bangalore Easter Science Congress, 1934.

technical language as "Linkage" and "Crossing-over" respectively.

Both the cultivated and the wild species of rice so far examined contain 12 pairs of chromosomes and according to the chromosome theory all the inherited characters must fall into 12 groups. We have so far studied the inheritance of nearly 100 characters and we have been able broadly to account for nearly 8 groups and the detailed inter-relationships amongst the members of each group have yet to be worked out.

That very striking results of improvement have not been effected in spite of the fact that artificial hybridisation has been practised in Coimbatore for the last several years is due to the fact that our knowledge about the complicated inheritance of several quantitative characters, which are the ones directly related to yield, is only gradually accumulating. Mention can, however, be made of two instances where hybridisation has met with success. There is now one strain issued from Aduturai (Adt. 8), a progeny of a hybrid made on the station, which while giving the same yield or even slightly more than Adt. 2, one of the parents, comes to maturity a fortnight earlier, which is a big gain as it can be more successfully grown than Adt. 2 wherever there is scarcity of water towards the end of the season.

The Rice plant is subject to a serious fungus disease, *Piricularia oryzae*, and when this breaks out in an epidemic form, practically the whole crop is lost. In the cases of diseases of agricultural crops, curative methods are practically out of question and the breeding of resistant types is the only weapon available with the breeder. Special crosses were made between *korangu samba*, an important variety of the Tanjore district and which is specially subject to this disease and two of the Coimbatore strains, GEB. 24 and Co. 4, which are found to be resistant. This work is now nearly 8 years old and has come to the stage when a few of the progenies from the first cross are found to be resistant to the disease besides giving a very much bigger yield than the susceptible variety.

The question of improvement does not cease with the evolution of strains, either direct selections or selections from hybrid progenies. There is another aspect of improvement, that due to 'nurture' as different from 'nature' involved in breeding. The yield which is the main consideration, is the end expression of all the vital processes of the plant throughout life, and to study yield, we have to make an analysis of the components of yield and how they are modified by the environment the plant is placed in. The study of the developmental phases of the rice plant has received considerable attention in recent years. One of the important developmental phases is tillering, or the production of side shoots. This phase goes on continuously for about 6 weeks after transplanting, depending upon the age of the variety, followed by a decline caused by the late tillers dying off, so that the number of final ears formed in each plant is only 50—70% of the total tillers produced. The production of the ears has a direct relation to tillering. In early varieties, under 4 months in duration, the formation of the rudimentary ear commences about two weeks before the maximum tillering phase is reached; in medium duration varieties, say 5 months, the two events synchronise; and in long duration varieties, 6 months and above, there is an apparent quiescent period of about 6 weeks after the maximum tillering phase is reached. These different developmental phases have a bearing on the cultural and manurial practices. One of the cultural practices involved is the spacing given to the plant at transplanting time, the more the spacing the greater is the number of tillers produced, but there is an optimum for each variety and each locality beyond which increased tillering induced by extra spacing cannot compensate for the reduction in the total number of tillers per unit area. In the early stages of the crop, spacing has even a greater effect on tillering than manuring.

The time at which manuring has its greatest value depends upon which stages in the plant's development are most intimately connected with yield, and which are most influenced by differences of manuring and soil fertility. The question whether the available manure should be given to the seed-beds or to the transplant field has been examined and it is found that manuring of the field rather than the seed-beds is more desirable. The application of a quick-acting manure like ammonium sulphate to the crop has been experimented with, and it has been found that it must be applied immediately after transplanting for a short duration variety while it is advantageous to postpone the application, up to 2 months after transplanting, for a long duration crop.

Hitherto the problem of breeding has been mainly confined to quantity, rather than to quality because quality does not come in at all in the polished rice as is generally consumed in the country. The antineuretic vitamin $B_1$, the proteins, and oil contained in rice are all to be found in the germ or embryo and the seed coat or bran which gets completely removed in the polishing processes. That varieties differ from each other with regard to the thickness of the seed coat has become evident from the histological study of the grain made in Coimbatore. Some of the coloured rices are found to have thicker bran than the white rices. In the interest of better health and nutrition when the craze for the highly polished white rices disappears, an unpolished rice with a thicker bran must be certainly more nutritious than one with a thinner coat, and the problem of producing rices with a thicker coat combined with yield is under investigation. Besides the vitamins and proteins there are certain other aspects concerned with rice nutrition about which little is so far known. These are concerned with the problem of storage and the changes taking place during storing and in the conversion of raw into par-boiled rice.

Coming to the recent developments in the study of the rice plant, the determining of the several linkage groups and the inter-relationship among the characters of each group is being pushed through by making suitable crosses between selected pure lines whose genetic constitutions are known. Though crosses are also being done with a view to synthesise useful characters in one type, the question of linkage often sets up a limitation to our getting any and every type of combination of characters. There have been several instances where the crosses failed to give useful results with regard to the combination of valuable characters like tillering, non-lodging nature of the straw, density of panicle, etc. In addition to the problem of linkage there were several cases where the progenies of crosses began to throw in the $F_2$s and later

generations various semi-lethal chlorophyll deficient types and completely lethal albinos though these were not present in the parents themselves.

In addition to the above, several cases of sterility where the spikelets remain chaffy without developing any grain are also met with. The chief manifestation of such spikelet sterility is the occurrence of non-viable pollen or male gametes. Cytological studies are able to connect the sterility with the peculiar behaviour of the chromosomes. Usually in interspecies crosses involving different numbers of chromosome the sterility is caused by the presence of these unpaired univalent chromosomes. This, however, does not apply to rice as all the species of Oryza so far examined have the same chromosome number. Sterility in this case must therefore be due to the different genic constitution of the chromosome sets. This is the characteristic of crosses between different geographical races.

Several cases of chromosome irregularities have been met with. There have been one or two instances where due to a stimulus, seed has formed without the fusion of the male gamete with the egg, the result being the plant arising from it contains only half the chromosome set, *haploid*. This plant is very much reduced in size, and completely sterile. Such a plant is found to set seed very occasionally due probably to the chance union of the haploid complement of chromosomes. The plants arising from such seeds should be absolutely homozygous.

Plants have also occurred with three sets of chromosomes instead of the usual two, *triploids*, due to the union of a male gamete with an unreduced egg. Such a plant is also sterile because of the uneven number of chromosomes but it occasionally sets seed giving rise to *polysomics*, where, in addition to the diploid chromosome sets, there are one or more extra chromosomes. Plants with $2n+1$, $2n+2$, and $2n+3$ chromosomes have been obtained, the increase in the number of extra chromosomes being associated with corresponding decreases in stature, vigour, etc., of the plants containing them.

Recent researches in some plants have led to the production by artificial means of *tetraploids*, where, instead of the two sets of chromosomes, there are four. These that arise by the duplication of the chromosomes, are usually bigger in stature, more vigorous than the *diploids*, and form a new species altogether. These have been produced from hybrids of different species which though sterile become fertile by the doubling of the chromosome set brought about by suppression of the cytoplasmic division at meiosis. After repeated attempts a successful cross has been obtained between two species of Oryza, *O. sativa* and *O. latifolia*, and the production of tetraploids from this hybrid is being attempted. This attempt, if successful, should prove extremely interesting.

In addition to changes that occur in the whole chromosome sets as in the cases mentioned above, there can also be changes in the genic make-up of the chromosomes, such changes being termed point or gene mutations. Treatment of the plants with X-rays has been found to be a prolific source for producing such changes artificially. The work of subjecting rice to X-rays has already begun in Coimbatore. Some of the pure lines have, as a result of the X-ray treatments, thrown dwarfs, albinos, chlorophyll deficient types, etc., which usually occur in the progenies of definite crosses. The plants resulting from X-rayed seed are found to be sterile and their cytological studies are proving extremely interesting. Among other chromosomal disturbances chromosome rings are found to occur in the meiosis obviously due to reciprocal translocation of parts of non-homologous chromosomes.

Plant breeding as a branch of agricultural science stands for producing new crops or plants, the introduction of which should bring a greater return to the cultivator. It is well to recognise that the outlook of the breeder is thus conditioned by restrictions from which pure science, as a branch of scholarship, should be kept free. As the previous narrative has shown, rice breeding work in Madras has, by the evolution of a large number of superior strains and their cultivation by the ryots, materially increased the production and hence the return to the grower, but due, unfortunately, to the present slump in the rice market, the position of the Madras rice-grower is anything but bright. Prices have gone down terribly and in some cases even to the extent of 200% over the prevailing prices 3 or 4 years ago. Such a fall cannot easily be accounted for. At any rate over-production is certainly not yet a contributory cause. It is hoped that the enquiries of the special officer recently appointed for the purpose will throw light on the problem and result in finding ways and means of bringing some relief to the rice cultivator.

## Optical Technology.*

By Dr. H. Parameswaran, M.A., Ph.D., D.Sc., F.Inst.P.

IN recent years the sciences have certainly reached a high state of development in India. The original contributions, reckoned either by their quality or quantity, constitute a record of which we could be proud. But when one considers the extent of knowledge of a practical character that prevails in the country which is necessary for the manufacture of apparatus with which these researches are carried out, one will make rather dismal discoveries. Not only is there a complete lack of instrumental skill but there is also a sort of contempt for the acquisition of that knowledge and skill. There is also a tendency to regard such knowledge and skill as purely mechanical and unscientific. I do consider this tendency highly detrimental to our material progress; the science of Physics comprises also applied and industrial aspects capable of extensive commercial application and it is high time that we concentrate and direct our scientific knowledge to this much-neglected direction and produce results

* Text of a paper read before the Bangalore Easter Science Congress, 1934.

of the greatest economic importance to the country.

I am particularly anxious that I should not be misunderstood. Theoretical researches will and should be going on under those specially inclined for it, but whatever we try to do by spending the country's feeble resources it should be useful and calculated to benefit the large suffering population.

We already see before us the sorry spectacle of a modern mechanical civilization coming into violent contact with a simple agricultural population. It has just educated them to increase their wants for manufactured articles before teaching them to manufacture them themselves. We find a similar deplorable state of affairs prevailing in the field of science as well. To take a simple example let us consider the familiar Raman effect. It is true it has given us international reputation. But it has not served to feed us. It has promoted the manufacture of a large number of costly spectrographs and their accessories in other countries. But in our own country it has only helped us to increase our imports of these very costly apparatus. Although I have the greatest admiration for the academic triumphs of our countrymen, I cannot but help feeling that some at least of these men would have done much better if they had directed their knowledge of physical science to the making of these costly spectrographs and their accessories. Work of this character does belong rightly to men of these academic attainments as well for in the design, construction, testing and adjustment of these instruments one finds ample scope for every variety of scientific knowledge. The very cost of these apparatus makes it worthwhile for an M.A. or M.Sc., getting in India barely Rs. 50 a month to engage himself in producing apparatus costing more than Rs. 2,000 a piece.

In work of this kind I find that the ratio of the cost of the finished product to the cost of the raw material range anywhere from ten to fifteen. The capital outlay required is comparatively small and hence particularly suited to small-scale production by individual efforts. Thus it is a line most directly suited to employ modern scientifically educated Indians. But as things are at present in India with our education in the universities running purely on academic lines divorced so much from practical realities with little insistence on knowledge of detail and practical skill, it is almost impossible to use the educated material available to-day for any such purpose. It affords in a way an explanation for there being so little of scientific instrument making in India to-day notwithstanding the enormous scope for it in this country.

Subjects like high class optical work on which is based the construction of spectrographs remain practically unknown even in the highest academic circles in India. To combat this deplorable position, we, at the Madras Presidency College Physics Department, have been devoting some attention to Optical as well as other aspects of Instrument Technology for the last ten years. We have been able to develop successful processes and methods for the production of high class optical surfaces—both large and small, plane and curved. There might be a feeling whether these products of ours finished by research students as by-products of their optical researches are exactly equal in quality to those imported from abroad. We are quite alive to our imperfections; at the same time the results achieved are very encouraging and our optical products employed under comparable conditions often give pretty much the same performance undistinguishable even by experienced workers.

There seems to be a universal belief even amongst scientists that work of this kind is based upon a large number of trade secrets. This appears to be largely untrue. At the same time it must be remembered that every successful work cannot but be having its own special processes developed by years of experience in the field. These cannot, by their nature, be public property. Beyond this I do not think there is anything of the nature of specially guarded secrets in the optical industry.

The raw material, optical glass, in any quality (dispersion) is easily purchaseable from well-known makers like Messrs. Chance of Birmingham. It is different from ordinary glass in that it is very homogeneous in composition and perfectly annealed to free it from double refraction arising from strains. It can be obtained from the makers in any size and shape. The next material is carborundum powder sold in a variety of grades of fineness. By working the glass against cast iron tools using a paste of carborundum powder and water as abrasive the glass surface can be made plane or curved as desired and given the requisite degree of fineness. This fine ground surface is then rubbed on a surface of pitch using a paste of rouge and water as the polishing medium, which results in the surface developing rapidly a good polish.

So far the work may be said to be mechanical and the piece of the article has barely doubled the price of the raw material used. Next comes the difficult and careful operation of figuring which alone gives the finished piece the optical perfection and is responsible for its proportionately high price. During this operation frequent optical tests, involving considerable scientific understanding of the factors involved, are required to control the work; and if one fails to make the correct interpretations of the appearances and adopt the proper remedial measures, articles of the required finish and accuracy are never attained. Foucault's tests for concaves, Newton's rings tests for planes and complimentary surfaces in contact are fields where our graduate physicists can find ample scope for the physics they have studied.

Very many optical pieces that are required in such large numbers in laboratories for conducting the routine teaching operations do not require any very high class finish and figuring and they can easily be made in India to-day. Work of a higher class, like Interferometers, have also been attempted at Madras by special processes with considerable success. We have now on hand a 24-inch diameter glass disc to be made into a paraboloidal mirror of focal length 12 feet for a reflecting telescope which, when finished, will be the largest telescope in India.

A point of doubt which it may be advisable to clear, is about the relative merits of hand-working and power-working. The amount of power required for optical work is in any case very very small and quite a considerable lot of work can be done by hand alone. But the preparation of such surfaces like the 24-inch disc is certainly hard work for the hand. In such cases, very simple inexpensive machines requiring not more than one horse power can easily be improvised.

The mechanical operations involved in the mounting of these finished optical parts into complete instruments, calls for no great equipment or outlay other than that of a modest workshop and good scientific guidance.

Thus, considered in every way optical or instrument technology seems to be a line in which the attention of the scientifically educated but unemployed in India should get interested, and it is hoped that in providing the necessary training the Indian Institute of Science will play its part.

## Science Notes.

*Lady Tata Memorial Trust.*—The Trustees have announced the award of the following scholarships for the year 1934-35, on the occasion of the third anniversary of the death of Lady Tata:—*International Scholarships* (£ 400 per mensem) for research in diseases of the blood with special reference to leucæmias—Dr. Walter Bungeler (Free Town of Danzig); Dr. Leonid Doljanski (Copenhagen); Dr. Martin Gril Gordon Isræls (Manchester); Dr. Charles Oberling (Paris); Dr. Julius Enzelbreth Holm (Copenhagen); Dr. Max Otto Kaalund-Jorgensen (Denmark); Dr. Rolf-Meier (Leipzig); Dr. Lucy Wills (London). *Indian Scholarships.*—(Rs. 150 per mensem). H. D. Srivastava (Allahabad); S. K. Ganguli (Calcutta); N. C. Datta (Bangalore); M. V. Radhakrishna Rao (Waltair); M. C. Nath (Dacca), A. R. Rajavanshi (Allahabad); B. D. Kochhar (Lahore); S. K. Mahabaleshwar (Manchester); K. N. Gaind (Bangalore); and Y. V. Sreenivasa Rau (Bangalore).

* * *

*India Institute of the Deutsche Akademie* has announced 21 new scholarships for the acadamic year 1934-35, for carrying on higher studies in various German Universities. The successful candidates are:—(1) A. K. Ghose, M.Sc. (Chemistry); (2) B. C. Roy, B.Sc. (Applied Geology); (3) C. D. Dwarakanath, L.I.M. (Medicine); (4) S. G. Joshi, M.B.B.S. (Medicine); (5) S. K. Sharma, M.A. (Sanskrit); (6) K. P. Mukhopadhyay, M.A., B.L. (Political Science and Economy); (7) B. K. Kar, M.Sc. (Botany); (8) T. V. G. Menon, B.A., B.Sc. (Agriculture); (9) Y. V. Sreenivasa Rau, M.Sc., A.I.I.Sc. (Plant Physiology); (10) Miss P. B. Devi, B.Sc. (Physical Chemistry); (11) D. C. Lahiri, B.A. (Medicine); (12) T. L. Kannappan Naicker, M.A., L.T. (Physics); (13) S. Vahiduddin, B.A. (Philosophy); (14) I. R. Barua, M.B.B.S. (Medicine); (15) Miss A. M. Jansz, B.A. (Economics and Political Science); (16) G. Kadambi, M.Sc. (Mathematics and Statistics); (17) A. K. Mitra (Anthropology); (18) D. R. Mehta, B.Sc. (Pharmaceutical Chemistry); (19) R. Ramamohan Rao, B.E. (Civil Engineering); (20) A. S. Gupta, M.B.B.S. (Medicine); and (21) Satyaketu Vidyalankar (History).

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*The Sir Pratap Singh Memorial Scholarships* (£ 100 each) tenable at the Indian Military Academy, Dehra Dun, have been awarded to Messrs. Muzaffar Khan (Campbellpore); Rawind Singh (Multan); Mahomed Sidiq Khan (Rawalpindi); and Wales (Rawalpindi).

* * *

*Imperial Institute Awards.*—The Imperial Council of Agricultural Research awards each year one Gold and two or three Silver Medals for improvements of distinct merit, in the science and art of Agriculture and Animal Husbandry of an All-India importance.

Applications are invited for the award of Medals during 1935 for Improvements in Dairying and Care of Animals. All entries should reach the Secretary, Imperial Council of Agricultural Research, through the proper channel by the 1st December 1934. Scheduled forms and other particulars can be obtained from the Secretary, Imperial Council of Agricultural Research, Simla.

* * *

Colonel Sewell, Leader of the Sir John Murray Expedition, and his colleagues who have been carrying on the Oceanographic Survey of the Arabian Sea since September last, have, according to a press report, made a spectacular discovery of the existence of a submarine mountain range running from Thagos Archipelago to Socotora in a line with Cape Guarda Firi on the East African Coast. Another submarine range was located in the Gulf of Oman running from North-East to South-East across the Gulf of Aden.

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A Provincial Research Committee with Lt.-Col. N. W. C. Noel, Director of Agriculture and Allied Departments, as President, has been appointed by the N.W.F. Province Government with the object of preparing Research Schemes for consideration by the Council of Agricultural Research. The Committee will work in close co-operation with the Imperial Council of Agricultural Research.

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A condolence meeting of the Staff and Students of the Royal Institute of Science, Bombay, was held on the 16th June to express deep regret and sorrow at the sad demise of Dr. A. N. Meldrum, the ex-Principal of this Institute. Dr. Meldrum was connected with the Institute for over 7 years, and it was under his able guidance that the germs of scientific research was first laid in the Institute in fact in Bombay Presidency. The Meeting passed a vote of condolence to the bereaved family of Dr. Meldrum and the Institute was closed on the 18th June as a mark of respect to his memory.

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Dr. Mata Prasad, Professor of Physical Chemistry, Royal Institute of Science, Bombay, has proceeded to England on a six months' leave to study the latest technique in X-ray Photography and Crystallography, which is his special subject of research. Mr. C. L. Mankodi is now working in place of Dr. Mata Prasad.

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Dr. W. McRae, D.Sc., F.L.S., Director, Imperial Institute of Agricultural Research, Pusa, has been granted long leave preparatory to retirement. He came to Pusa in 1908 but his services as Government Mycologist were lent to the Madras Government. He returned to Pusa again in 1919 and was appointed Director in 1931.

*Salt Manufacture in Bengal.*—The Government has issued a statement on the possibilities of salt manufacture in Bengal. The principal point at issue is the cost of manufacture, as on the Indian Market, Bengal salt, which as at present manufactured costs Rs. 3-3-0 to Rs. 3-13-0 per maund, cannot compete with salt manufactured in other parts of India; the imported salt sells at Rs. 2-13-0 to Rs. 3-3-0 per maund. A new method of production appears to have vast possibilities. This is based on the procedure now adopted in Burma; pits are dug in the factories situated on the Arakan Coast, and the sea water which percolates into these possesses a high degree of salinity and this can be profitably utilised for manufacture of salt by evaporation.

* * *

*Life and Conditions of the People of Hindustan from 1200-1550 A.D.*—In a paper presented before the July Meeting of the Asiatic Society of Bengal, K. M. Ashraf has given an account of the social life in Northern India under the Muslim Sultans of Delhi before Akbar. For the collection of the data the author has made use of copious materials scattered in various Arabic, Persian and Nagari works, comprising surveys of general and special histories, accounts of travellers, books of poetry, folklore and fiction, legal compendiums, mystic literature and works on ethics, politics and various practical arts. The thesis is of interest for the understanding of the social interactions of Hindus and Muslims during the first period of their contact in Northern India and provides a proper background for the study of the later social developments.

* * *

"*Science*" reports that the Sixth International Congress on Industrial Accidents and Diseases offers a prize of 1,000 Swiss francs as an award to the author of the best (unpublished) original work on the subject "The Importance of Previous Physical Condition in Estimating the Sequelæ of an Industrial Accident". Physicians in all countries are permitted to take part. Manuscripts must be on hand by 31st December 1934. The award will be made at the time of the Seventh Congress to be held in Brussels in July 1935.

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The Raja of Sarawak, Sir Charles Brooks, has given £20,000 towards the Fund for building a permanent and self-supporting Imperial Forest Research Institute at Oxford. The proposed Imperial Forest Institute will be of great assistance in developing the timber resources. It is stated that at present 80 per cent. of the supplies come from foreign countries. The Institute will provide facilities for studies to the officers of different Forest Departments.

* * *

*Lighting for Cranes* [*Illumination Research Technical Paper No. 15, His Majesty's Stationery Office (Price 3d.)*].—"This report describes the investigations to discover the most satisfactory system of crane lighting both from the point of view of the crane driver and of the workers on the quay by combining so far as possible adequate lighting with absence of glare.

While the paper itself is concerned only with shore cranes, it may often be both possible and desirable to apply the conclusions reached in other directions also."

* * *

*Eradication of Water Hyacinths by Spraying.*—Mr. Subimal Bose of Calcutta, the discoverer of a new spraying preparation for the eradication of the pest, has been carrying out several successful demonstrations in and around Calcutta. When sprayed on the plants, the leaves and stems wither in about a week and the plant dies after a fortnight. The preparation appears to be free from ingredients endangering the life of men, animals or fish, and can be produced at a small cost so as to be within the reach of even poor cultivators.

According to Mr. Bose a spraying solution was prepared by Mr. T. S. Griffiths in 1921 for the eradication of water hyacinth. A Committee of Scientists who tested Mr. Griffiths' preparation opined that its value was doubtful.

* * *

*A Twin Boll of Cotton.*—Mr. B. S. Nigam, Agricultural College, Cawnpore, writes to us about an unusual case of a twin boll of cotton which he observed a few weeks ago. "Cotton plant is known to produce single loculicidal capsules from solitary flowers. While passing through a field of cotton the author chanced to notice a twin capsule. Both the capsules were borne on a single peduncle and dehisced as usual. The twin had two whorls of epicalyx. Each capsule had four compartments. Those on the inner side were smaller in size than the outer one. There were 33 seeds in both the capsules; 18 and 15 respectively."

* * *

*Change of Sex in the Male Plants of Carica papaya, Wild, by Decapitation.*—Mr. G. P. Mujumdar, Presidency College, Calcutta, in the course of a communication on the subject, writes, "In the May issue of *Current Science* (1934, **2**, 428), Mr. S. Sarup published a note on 'Sex Control in Papaya'. Evidently he thought that his was the second report of the phenomenon, the first being made by Wilcox in 1916. Reyes, however, published a paper in 1925, and as early as 1930, I read another paper, for the first time in India, before the Botany Section of the Indian Science Congress, in which I pointed out from my own observation that (1) this method of changing sex in papaya is to some extent successfully practised in Deoghar (Bihar), (2) the best results are seen in transplanted plants, and (3) sometimes repeated toppings are necessary to effect the desired change.

In one respect, however, Mr. Sarup's paper is interesting. He reports cent per cent success, and his plants were transplanted ones. Thus he supports my second observation. The very small percentage of success in the Hawaii Experiments only 2 out of 22 and 83 plants might be, it seems to me, due to the experiments being carried on in non-transplanted plants."

* * *

*A Curious Abnormality in Rose.*—Mr. S. Sarup in a communication describes a curious abnormality he observed in a garden at Jodphur. He says, "The rose flower had been pierced by the axis and the axis had continued its growth after that, producing three leaves at the first node about 2½ cms. above the insertion of the flower. At the second node 4 cms. higher up another leaf was produced. The axis then terminated in a flower. The leaves were all perfectly developed. The flower that had been pierced consisted of the usual number of sepals, one recurved and five

petals. The petals were about 3 cms. long and appeared to clasp the protruding stem. The internodes between the insertion of the pierced flower and the first node above being shorter in length than the petals, the three leaves arising at this node appeared to come out of the flower. One petal, however, had opened out. There was no trace of the presence of the essential organs.

The midrib, the veins and the margin of the leaves above the pierced flower had the same pink colour as the petals. Under reflected light the whole leaf gave the pink hue. This was not the case with the leaves below the pierced flower. The axis had continued its growth to produce the leaves and another flower."

* * *

*Tetrahedrite as a Silver Enrichment Mineral*:—Mr. S. Krishnaswamy, University College, Rangoon, writes:—"From time to time many investigators scattered the world over, have shown that the silver-content in many ore-bodies have become appreciably augmented when some sulphides like the pyrites, tetrahedrite, etc., are found in association with the silver ore-minerals.

In 1931, while studying some Burma Argentiferous Galena ores under the Metallographic Microscope, by the polished Ore-methods it was noticed, that tetrahedrite was functioning in the case of the Burma ore as a silver-enricher. So to say, wherever the Argentiferous Galena Ore was found accompanied by tetrahedrite, the silver content of such ores were appreciably more than the average normal assay value for such ores occurring in the same lode but unaccompanied by the presence of tetrahedrite."

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We acknowledge with thanks the receipt of the following:—

"Nature," Vol. 133, Nos, 3367 to 3370.
"The Chemical Age," Vol. 30, Nos. 776 to 779.
"Canadian Journal of Research," Vol. 10, No. 5.
"The Journal of Chemical Physics," Vol. 2, No. 5.
"The Biochemical Journal," Vol. 28, No. 2.
"Berichte Der Deutschen Chemischen Gessellschaft," Jherg. 67, No. 5.
"Natural History," Vol. 34, No. 3.
"Journal of Agricultural Research," Vol. 48, Nos. 3 & 4.
"American Journal of Botany," Vol. 21, No. 5.
"Journal de Chemie Physique," Tome 31, No. 4.
"The Review of Scientific Instruments," Vol. 5, No. 5.
"The Mathematics Student," Vol. 2, No. 1.
"Scientific Indian," Vol. 11, No. 65.
"Indian Forester," Vol. 60, No. 6.
"Medico-Surgical Suggestions," Vol. 3, No. 5.
"The Quarterly Journal of the Geological, Mining and Metallurgical Society of India," Vol. 5, No. 3.
"Contributions from Boyce Thompson Institute," Vol. 6, No. 2.
"Forschungen und Fortschritte," Jehrgang 10, Nos. 15 & 16.
"The Indian Journal of Agricultural Science," Vol. 4, No. 2.
"Indian Forest Records," Vol. XX, Parts 1 to 5.
"The Nagpur Agricultural College Magazine," Vol. 8, No. 4.
"The Indian Trade Journal," Vol. CXIII, Nos. 1456 to 1461.
"The Journal of the Indian Mathematical Society," Vol. 13, No. 1.
"Department of Commercial Intelligence & Statistics in India—Monthly Statistics of the Production of Certain Selected Industries of India," March 1934.
"Journal of the Institute of Brewing," Vol. XL, No. 6.
Government Museum, Madras. Bulletin—New Series, Vol. 1, Part 3. "Tirupauttikumram and Its Temples."

## Reviews.

FIRST OVER EVEREST—THE HOUSTON-MOUNT EVEREST EXPEDITION, 1933. By Air-Commodore P. F. M. Fellowes, D.S.O., L. V. Stewart Blacker, O.B.E., P.S.C., Colonel P. T. Etherton, and Squadron Leader the Marquess of Douglas and Clydesdale, M.P. (John Lane, The Bodley Head Limited, London.)

"First Over Everest" is the official account of the Houston-Mount Everest Expedition of 1933. The plan of an expedition by air against the mountain was submitted by Major Blacker of the Indian Army in March 1932 to the Royal Geographical Society of London and in April 1933, two Westland planes flew over Mts. Everest and Kanchenjunga at a height of 32,000 ft. The maturing of the plan, the development of the organisation, the preparation for the flight, and the actual carrying out of the enterprise are fascinatingly told in this volume.

The scientific object of the expedition "consisted in a demonstration of mapping by air survey methods, of the inaccessible cliffs, glaciers and valleys of the southern side of Mount Everest. The aim was not so much to produce an extensive map of any immediate practical utility, as to demonstrate to the world, especially to the non-technical portion of it, the relative quickness with which such a map might be made of a region forbidden to ground methods not only by policy, but also by the physical obstacles of the country." To take good survey photographs from the air in a clear atmosphere over a level country is a comparatively simple matter, but over mountainous country with varying distances of the earth's

surface from the plane and with the possibility of unexpected bumps that might make it impossible for the pilot to keep the plane on a level keel is much more difficult. In the present instance, owing to the exceptional height and steepness of much of the ground, the vertical photographs had to be supplemented by a series of oblique photographs with known tilts of the camera both vertically and horizontally.

Because of this difficulty, the photographs obtained in the first flight were, from the survey point of view, so unsatisfactory that a second attempt had to be made. To add to the difficulties, the atmosphere of North India in April and May is often covered with thick dust-haze to a height of about 19,000 ft. which makes it difficult even with modern infra-red films to get good pictures of known ground features which would serve as reference marks.

The expedition fully realised that the success of the enterprise depended mainly on the favourableness of two meteorological factors—clouds and haze over the terrain and the force of the wind. During the month of April in which the flights were carried out, North India is periodically traversed by a more or less regular series of atmospheric disturbances travelling from West to East which cause cloudy weather and exceptionally strong winds at different stages of their passage over a place. It was also known from previous studies of winds over North India that the most frequent wind speeds over Everest would be as high as 60 to 80 miles per hour and that they would often exceed 150 miles per hour.

To meet the special requirements of the flight, the India Meteorological Department set up two pilot balloon stations at Darjeeling and Purnea (the base of the expedition) and arranged to send special forecasts of general weather and strength of upper winds from their office at Calcutta.

With regard to the information supplied by the India Meteorological Department, the authors write: "In addition, every evening the weather bureau at Calcutta telegraphed us at 21-30 hours, giving information of the general weather condition along the Himalayas and a forecast of what might be expected in the Mt. Everest region, especially as regards clouds and haze, and finally an estimate of the direction and velocity of the wind current to be expected at various heights up to 10 km.

"The accuracy of the information contained in these telegrams was remarkable and made it possible to plan the flying operations the next day, after they had been studied in conjunction with the balloon observations taken locally by Mr. Gupta (Upper Air Observer at Purnea). The flight to Mt. Everest was carried out with this information and the results of it, particularly the drift and measurement on the drift sights, confirmed to a remarkable degree both the observations and forecasts of the meteorologists."

I am tempted to add two more meteorological quotations, one on the 'plume' of Mount Everest and another on the experience of some of the fliers in a North Indian dust-storm.

"From the Moths we had seen what previous explorers had called the 'plume' of Mount Everest and had somewhat readily taken it for granted that it was merely a cloud, of which the component particles would naturally be frozen, and similar to that one usually sees in the vicinity of high mountains.

Kanchenjunga, for instance, was seldom without such a cloud wreath throughout April.

When, however, the machines actually went into it, we realised that it was something quite different to what we had conceived. Here was no drifting cloud wisp, but a prodigious jet of rushing winds flinging a veritable barrage of ice fragments for several miles to leeward of the peak.

The force of the *rafale* was indeed so great as to crack the celastroid windows of the Houston-Westland's rear cock-pit. We soon realised, too, that this 'plume' could not be composed of frozen matter carried over by the blizzard from the windward face, for the reason that the windward faces, that is, the western side, were practically bare, as may be seen from the photographs." The authors suggest that the phenomenon is due to an overfall of the winds over the crest of the mountain, giving rise to a zone of reduced pressure on the leeward side tending to draw up the air from the Tibetan side and with it great masses of old snow and fragments of ice.

Here is a description of the fliers' experience of a dust-storm. "We had risen high above the Agra plain and were some 70 miles on our way (to Jodhpur) when in the far distance a mighty wall seemed to rise sheer out of the earth, a barrier that mounted higher and higher and became

ever more thick and menacing, as though it would say 'thou shalt not pass'. We pressed on to meet the challenge, rising still higher until the altimeter registered 12,000 feet; but we might as well have risen to the stratosphere in the effort to get clear of the enemy, for the dark brown wall rose higher than we did, its vanguard was already in touch with us, whistling and howling around our tiny aircraft like a legion of devils.

"It was getting black as night, nothing was visible but the rampart of dark brown dust . . . . McIntyre never hesitated; he knew that the sane thing to do was to turn, and flying before the storm, make for the landing ground at Agra.

"We swirled along, slap-dash we burst into the very thick of the pursuing storm; gusts of the typhoon seemed to leap over us like harlequins in a pantomime . . . . On we went gaining on our pursuers and getting into a clearer atmosphere, but always with the storm close behind us, its force mobilised and trying once for all if it could not, by a tremendous effort, drive us from the air and sweep us off the face of creation. It very nearly succeeded; only the skill of the pilot saved us. . . . .

"We stayed the night at Agra, leaving again the next morning in a glowing light, an atmosphere of calm beatitude, without the faintest indication of the scenes that had been enacted the previous day."

The expedition successfully accomplished its task. It obtained all the photographs it wanted, and demonstrated to the world what modern aircraft, when used with understanding and pluck, could achieve. In addition to the geographical, meteorological, photographic and general aviation information set out in the book in a most interesting manner, there are interspersed throughout the book many shrewd remarks about the habits and customs of the people in India and other countries through which the planes flew. The book is illustrated with a large number of maps and beautiful photographs of Himalayan scenery.

K. R. R.

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CHEMICAL ENGINEERS' HAND-BOOK. Editor-in-Chief, John H. Perry, assisted by 60 specialists. *Chemical Engineering Series.* 30 sections, 2600 pages, $4\frac{1}{2} \times 7$, semi-flexible, thumb-indexed. (McGraw-Hill, 1934.) \$9·00.

The volume is produced on the same lines as Mark's *Mechanical Engineers' Handbook* and Fowle's *Standard Handbook for Electrical Engineers*, and embodies all the features, such as specialist contributors, concise presentation, attractive get-up, etc., that have contributed to the success of these Handbooks. The chemical engineer can at last find in this work a reliable source of information where a mass of theoretical and operating data representative of present-day practice is ably collated and presented under conveniently divided sections. The sections are well planned, comprehensive and readable, so that a perusal of the relevant section would be one of the best short-cuts for the busy engineer desiring an authoritative survey of information concerning any of the unit operations. While the allotment of space for the various sections is generally satisfactory, one would desire the sections on Evaporation, Materials of Construction and perhaps also Drying enlarged to roughly twice their present bulk so as to include the Hausbrand type of calculated data as also operating data of the kind found in the section on Crushing, Grinding, and Pulverising. If curtailment in other directions is essential, some of the larger sections (those on Physical and Chemical Data and Refrigeration may be mentioned) could be reconsidered with a view to abridgement. In Physical and Chemical Data one is apt to look for particulars of technical chemicals as to, say, availability, commercial grades, methods of purification, principal uses, etc. Flow sheets of important industries would form a highly useful addition to the section on Physical and Chemical Principles. The utility of the entropy charts found in the latter section would be much enhanced if these were reproduced to larger scale and collected at the end of the volume together with other charts of general interest, such as Grosvenor and Mollier psychrometric charts dealing with the principal industrial gases. Information concerning protective coatings is lacking. An entire section dealing with high temperature operations is *missing*, as it were; at any rate the sub-section on Radiant Heat Transmission could be expanded to comprise furnaces and kilns, refractories, thermal insulation, etc. Probably as a result of the rational classification employed, overlapping of subject-matter is negligible for a work of this nature. Electrometric pH measurement described in the section on

Electrochemistry ought to find its appropriate place, together with an account of the colorimetric methods and automatic control devices, in the section on Measurement and Control of Process Variables.

It would serve no useful purpose to compliment in any detail the editor and collaborators for the remarkable book they have offered the profession at the first attempt. Particular credit is due for the masterly presentation of data collected from diverse fields of knowledge, for a casual glance at the pages is sufficient to indicate the great number of fundamental sciences that the chemical engineer has to keep in touch with unlike the case of other engineering professions. Chemical engineering need no longer be regarded as has been done till recently even in advanced countries like Germany as *Maschinenkunde fur Chemiker*. In several sections there are evidences of the authors having waded through a mass of available data or scores of commercial types of equipment before presenting the basic principles in a convenient form. We shall confidently expect to find the Handbook in the possession of every engineer, every executive and, particularly, every student no matter however remote his connection with chemical or physico-chemical technical operations.

L. G. RAO.

AN INTRODUCTION TO THE BIOCHEMISTRY OF NITROGEN CONSERVATION. By Gilbert J. Fowler, D.SC., F.I.C., pp. vi+280. (London, Edward Arnold & Co., 1934.) Price 12*s*. 6*d*. net.

The monographs appearing in recent years can be classed under two main heads: (1) those which are of the nature of compilations dealing with vast amounts of matter and ending with extensive bibliography, and (2) those which relate, almost exclusively, to the author's work and those of his associates. In the former, the individuality of the author is practically lost while, in the latter, the reader is constantly reminded of the fact that the author is largely responsible for the development of the subject with which he deals. Dr. Fowler's monograph modestly titled "An Introduction", belongs definitely to the latter class.

The introductory chapter opens rather dramatically with some of the author's earlier experiences with the highly explosive nitride of silver and then leads on to the quieter activities of nitrogen with which the author has been associated in the later years. After this, the reader is acquainted with the principles of biochemical technique and then taken, through easy stages, to a detailed study of the various nitrogen transformations in the soil, the manure heap, the sewage tank and the filter bed. This is followed by a brief chapter touching on certain aspects of nitrogen assimilation by plants and then by a large section dealing, in detail, with the practical applications of scientific research to the making of compost, purification of sewage and increased crop production. The importance of nitrogen is stressed at each stage and various suggestions made for the conservation of that element under different conditions. The text is followed by appendices providing useful data relating to human physiological wastes and to nitrogen production and consumption with special reference to India.

The most interesting portions of the book are those which relate to the author's own contributions to the development of the Activated Sludge Process of sewage purification and to the disposal of various forms of solid wastes. These sections have been presented in a highly lucid, and at the same time, quietly confident strain which is invariably associated with thorough mastery of the subject. The related chapters are well worth the study of not only those who wish to be introduced to that subject, but also those who wish to specialise in it. A number of practical suggestions based on the author's experience have also been given which are well worth extensive adoption.

No human performance can ever claim to be perfect and Dr. Fowler's monograph is no exception to the rule. Some of the sections of the book, particularly those relating to the chemistry of the various processes, have not been presented with that intimacy of knowledge which characterises the other portions. The chapter relating to assimilation of nitrogen by plants is not so complete as one would wish. The section relating to chemical principles and bacteriological methods is too elementary for those who know something of those subjects and too technical for those who seek initiation into them through the medium of this book so that those pages would possess practically no interest to a large section of readers. References to literature are incomplete and in some cases a little far-fetched. In many cases, old researches have been cited while more accurate later work receives no mention. In certain lines, the references have

been largely confined to those of the author and his associates while similar and even more exhaustive researches conducted in other parts of the world are not cited. This is probably due to the natural desire of the author to refer only to those pieces of work with which he is intimately acquainted, but it is hardly likely that such a view will be shared by a large section of readers—especially those residing outside India. It is hoped that these defects would be attended to when the second edition is prepared.

The book is written in excellent style and, as distinct from many other monographs of the present day, is eminently readable. The printing and the binding leave nothing to be desired. The publishers deserve to be congratulated on their excellent production.

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AN INTRODUCTION TO BIOLOGY. By Elbert C. Cole, Ph.D. (John Wiley & Sons, New York, Inc., Chapman & Hall, Ltd., 11, Henrietta Street, Covent Gardens, London. xiii+496 pp. 1933.) Price 11*s*. net.

This is one of the finest text-books on the subject of biology and we have pleasure in recommending its use in all schools and colleges where biology forms an integral part of the curriculum of studies. The book, according to the author, is intended to provide material for a full year's course; but under the conditions prevailing in the Indian Schools and Colleges, where hardly two hours in the week are devoted in the Time Table to the teaching of the subject, we should regard it safe that the topics dealt with in the book, had best be treated as a two years' course. Almost all the Indian Universities have included biology in their syllabuses—though the University of Delhi thinks that the subject is in the nature of a luxury,—and we can hardly think of a better book for the Intermediate course at which stage, the pupils establish specific interests in their academic career. No educational programme can be sound which omits biology from its purview and both for information and discipline, it is inferior to none of the other scientific subjects. We would go a step further and stress the point that every citizen needs training in biological subjects for the proper and efficient discharge of his duties and responsibilities as a municipal member.

Among other interesting topics dealt with in the book, the author gives prominence to the similarities of organisms in structure and function, the dependence of the organisms upon one another and upon the inorganic world, their economic importance, and the phylogenetic relationship. The section on the control and improvement of organisms, contains a great mass of information of intimate practical interest both to the Government and to the people and in these days of unemployment among the educated communities, a knowledge of the improvement of organisms might offer avenues of fruitful occupation, provided the young men have sufficient enterprise and willingness to work in other than routine fields.

The book provides practical guidance to teachers of biology and every chapter closes with a beautiful summary of the subject. Students are given projects and also references to other works for additional studies. All technical terms are defined correctly and briefly in simple terms. The illustrations are sumptuous. The book is typical in every respect. It provides sufficient material for selection suitable to Indian conditions.

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## Forthcoming Events.

*The Bangalore Educational Association.*—The Educational Week Celebrations, 1934, including the Educational Exhibition, will commence on the 11th August 1934. Amin-ul-Mulk Sir Mirza M. Ismail, KT., O.B.E., will inaugurate the Week.

*Lectures on Theory of Electronic Valency.*—Dr. T. S. Wheeler will deliver a series of lectures at the Royal Institute of Science, Bombay, on every Saturday during the current term.

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CONTENTS.





## From Pusa to . . . ?

THE disastrous earthquake of last January brought with it a chain of problems not the least important of which is the future location of the Imperial Institute of Agricultural Research now situated at Pusa in Bihar. The buildings of the Institute were badly damaged by the earthquake, so, on the recommendation of their experts, the Government decided to abandon them and construct new ones in the neighbourhood of Delhi. This decision, which would involve far heavier expenditure than repair to the old buildings, has now met with considerable opposition. The controversy has indeed assumed such serious proportions that not a day passes without some communication to the press–an important interview, resolution passed at a public meeting or proceedings of a lively discussion at a council of legislatures. Although the social, the economical and the political aspects of the question are now being hotly debated, yet very little is heard regarding the technical considerations which prompted such a decision. In fact, the scientific opinion of the country has hardly expressed itself on this highly important question. It is our present object, therefore, to view the position mainly from the scientific standpoint and to consider the possible influence of the proposed transfer on the progress of agricultural science in the country.

It is argued by those in favour of the transfer that Pusa being in the heart of a region frequently subject to earthquakes, more shocks might follow in the future and the entire building might soon collapse causing considerable loss of life and property. This danger can be eliminated by transferring the Institute to Delhi. Furthermore, the transfer will remove certain disabilities from which the Institute suffered in the past. The soil conditions in the neighbourhood of Delhi will be more representative of the Indo-Gangetic plain than the naturally rich tracts of Pusa. The Institute will also be more accessible and bring the officers into better contact with legislators, agriculturists, industrialists and others visiting Delhi from time to time.

Among those who are opposed to the transfer, (1) a large number are definitely in favour of retaining the Institute at Pusa itself after strengthening the buildings in such a manner as to withstand future

shocks; (2) some are for distributing the activities between different centres; and (3) others are for shifting the Institute to the neighbourhood of a centre of scientific learning like Allahabad, Bangalore, Bombay or Calcutta. The first group of opponents point out that, in recent years, a number of building materials have been discovered which can withstand earthquake shocks. Such materials can be used for repairing and reinforcing the buildings at Pusa. They also hold that Pusa has always been accessible to those who are interested and that the soil conditions at Pusa are not greatly different from those prevalent elsewhere. The second group argue that India is a vast agricultural country with varying soil and climatic conditions, so that no single institute situated anywhere can adequately meet the needs of the whole country. They plead therefore for a number of research institutions distributed throughout the country. The last group agree that Pusa is not suitable but point out that Delhi is also unsuitable. The scientific workers require isolation and peace rather than the crowded and disturbed atmosphere of a political centre. They favour, therefore, the transference of the Institute to the proximity of a centre of learning where a scientific atmosphere would prevail, where there is likely to be the least disturbance at work and minimum interference from those in power. There is something to be said for each point of view, so all the facts should be taken into consideration before arriving at a decision.

Before taking up a discussion of the various technical points at issue, it would be of some assistance if we could define, in a general way, the objects of the Institute, and the type of facilities that are required for carrying them out. It is true that for a long time, the Pusa Institute, with its various sections and sub-sections distributed in the different provinces of the country, was the only centre of agricultural research. Problems of not only All-India character but also those of provincial interest had therefore to be investigated by the Institute. Post-graduate training in agricultural science had to be imparted and the staff of the newly created provincial agricultural departments trained in methods of research. To-day, the conditions have greatly altered. Most of the provincial departments have been adequately organised and are in charge of competent men who could deal with all the local problems. Many of the Universities, as also research institutes, have organised post-graduate training in different branches of agricultural science so that the need for special courses of the type that was in vogue in the past has also greatly disappeared. Even problems of all-India character which the provincial departments cannot adequately handle are fast diminishing, so the Institute is now largely free to devote itself to problems of fundamental interest. In view of the importance of this type of work and the misconception that generally prevails regarding the utility of fundamental research, we wish to deal with it at some length.

The history of the development of scientific agriculture, as also any other branch of applied science, shows that the most important discoveries are made not by those working on fields or in factories but by pure scientists who plod in the seclusion of laboratories and pot-culture houses for the mere sake of small additions to knowledge. Those engaged on field work or factory operations are largely concerned with the immediate problems of their work and cannot find either the leisure or the opportunity to think out new ideas and to investigate their possibilities. On the other hand, the pure scientist has very few such worries and has often the freedom to think boldly and the facility to work out his ideas irrespective of cost or considerations of immediate return. Most of his researches may be of purely academic interest, but a single accidental finding with a new idea for its background may lead to the most far-reaching developments and thus make up thousand-fold for all the failures in the past. Such is the value and significance of fundamental research conducted by right men in the right environment; such is the right spirit in which agricultural research is being carried out at Rothamsted and other leading experimental stations of the World; and such should be the ideal before those in charge of the destinies of the Imperial Institute of Agricultural Research. Administrative routine and commercial enterprises should be reduced to the minimum and the research workers given ample freedom and facilities to devote themselves to fundamental research.

Let us now proceed to critically examine the various suggestions that have been made and to determine how far they would help towards the attainment of the ideal before

us. Taking first the suggestion that a number of research institutes should be created, we should agree that it would be quite useful to have them, though not for the purpose intended by some of the proposers. There is ample scope for several lines of fundamantal research but there is no need to duplicate the advisory work now conducted by the provincial agricultural departments. As for the proposed distribution of work between different provincial centres, it is highly undesirable. The different sections should be together at one place so that the workers may have opportunities for meeting each other and discussing problems of common interest.

Assuming that, at least for some time to come, there will be only one Imperial Institute of Agricultural Research, we shall next consider the type of facilities required for conducting fundamental work of a high order. Firstly, the Institute should be situated in a healthy locality which enjoys a salubrious climate. From this point of view there is not much to choose between Pusa and Delhi. Both the places are as good or as bad as most other places on the Indo-Gangetic plain. If a better climate is sought, the claims of Dehra Dun, Poona or Bangalore will come for consideration. Secondly, the buildings should be safe and there should be no fear of danger to life and property. An unsound building in an area susceptible to frequent earthquake shocks has an adverse effect on the morale of the workers though there may be no real danger for several decades to come. Before condemning the present buildings at Pusa, however, every effort should be made to strengthen them. Reinforced concrete is suggested as a suitable material for safeguarding the buildings against future shocks and it is for the experts concerned to conduct some rigorous tests with that and other materials before pronouncing the buildings to be beyond the stage of repair. Thirdly, there should be ample laboratory and library facilities. These are now being liberally provided by the Imperial Institute and will continue to be available irrespective of location. Fourthly, there should be a proper scientific atmosphere both in and around the place. This is of the greatest importance if work of high order is to be turned out. The scientific atmosphere of a place is partly due to tradition and partly to the example of some of the senior workers. Even a small band of enthusiasts with proper scientific outlook can infuse new spirit into a place and impart new traditions. Equally important is the scientific atmosphere around a place. There should be in the neighbourhood a number of research institutions devoted to other branches of science so that specialists in different fields will have opportunities to meet each other and discuss problems of common interest. Contact with workers in other fields widens one's outlook and facilitates better understanding of scientific problems. It infuses a spirit of comradeship and leads on to co-operative undertakings in which specialists in different lines join together in the investigation of problems of common interest. It even promotes a spirit of healthy rivalry which is highly desirable and helps to draw the best out of the workers. It is indeed this apparently vague, but nevertheless real, scientific atmosphere which is the secret of the success of most of the leading scientific institutions of the World. Judged from this point of view, both Pusa and Delhi will stand condemned. Pusa itself is isolated and the nearest centre of learning is Patna, a good distance away, on the other side of the river. Calcutta is still farther away and a long and expensive journey has to be undertaken to reach it. Benares and Lucknow are also a long way off. Coming to Delhi, it is undoubtedly a great political centre. Members of legislature and other leading citizens of the country visit the place from time to time. Meetings of the Advisory Board and the scientific committees of the Imperial Council of Agricultural Research are also being held there at least once a year. In spite of these associations, Delhi has yet to build up a scientific atmosphere. The Colleges in Delhi have, unfortunately, very few facilities for scientific research, so naturally much should not be expected from the University. Among the other centres of learning, Agra is some distance away; Lahore and Allahabad are farther still so that Delhi may also be regarded as isolated from the scientific point of view. If a transfer is decided on and if the value of proper scientific environment is taken into consideration, the Institute should be removed not to Delhi but to the neighbourhood of Allahabad, Bangalore, Bombay, Calcutta, or Lahore any one of which would be found more suitable.

In a vast country like India, no single place can be regarded as being easily accessible from all the provinces. If Delhi is easily accessible from the Punjab, Bombay, Central

India and certain parts of the United Provinces, Pusa may claim to be accessible to Bihar and Orissa, Bengal, Assam, parts of Central Provinces and a large section of the United Provinces. Both the centres may, on the other hand, be regarded as being inaccessible to Madras, Mysore, Hyderabad and South India in general. Thus, the charge of being inaccessible may be levelled against any place in India so that it is not quite fair to condemn Pusa mainly on that account. The things that really matter are good facilities, right talent and proper scientific atmosphere : if these are ensured, an institute situated even in the most obscure corner of the country can come to the forefront, and attract visitors not only from the whole of India but other parts of the World as well.

V. S.

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## The Malarial Parasites of the Oriental Monkey, *Silenus irus*.*

By Lt. Col. J. A. Sinton, I.M.S.

(*Malaria Survey of India.*)

ONE cannot fail to be struck, in any study of the literature on malaria, by the paucity of the experimental evidence in support of many of the theories put forward. This is mainly due to the fact that all attempts to infect any of the common laboratory animals with the Plasmodia of human malaria have proved unsuccessful. Although much information has been gathered from the researches into avian malaria, there are many disadvantages and limitations in this work. Moreover, it is sometimes difficult to say exactly to what extent the results obtained are applicable to the human problem.

The discovery of the value of malarial infection in the therapy of certain nervous disorders, has opened up a wide field for gathering invaluable experimental evidence. Even under these more satisfactory conditions, the fact that human infections cannot be allowed to run their natural course, in many instances, restricts the usefulness of this line of investigation.

The monkey is the only one of the mammals commonly used for experimental work, in which the presence of natural malarial infection has been confirmed. The fact that such infections occur in a Primate host, suggests that the investigation and study of these conditions would give results more comparable with human infections than could be obtained with the avian type of disease. That malaria in monkeys might provide very valuable material to the malariologist, has long been borne in mind by workers in India.

Very many attempts made by them to discover such infections in the common brown monkey of northern India [*Silenus rhesus* (*Macacus rhesus; Macaca mulatta*)] have proved unsuccessful. This fact has often been deplored, but more recent evidence would appear to indicate that the absence of natural infection in this species of monkey is a fortunate occurrence, from the point of view of the research worker in India. The absence of such natural malarial infections in *S. rhesus* makes available large numbers of uninfected and susceptible Primates for experimentation. Workers on simian malaria in other countries have been greatly hampered in their investigations by the lack of such types of animal.

Malarial infections of monkeys were first recorded by Koch in East Africa in 1898. Since then many species of *Plasmodium* have been reported from various monkeys in different parts of both the Old and New Worlds. Many of the earlier investigators carried out experimental work with such infections. More recently, extensive researches have been reported by workers in America, Malaya and India. The latter work has confirmed the view that from a study of monkey malaria the solutions of many unsolved problems in human malariology may be obtained.

Research in human malaria has shown that the clinical and pathological manifestations of this disease, as well as its reaction to different therapeutic agents, vary with the species of *Plasmodium* responsible for the infection. It is, therefore, essential that an accurate specific identification should be made of the parasite used in any investigation. It is equally important to ensure that the infection studied is due to one species of *Plasmodium*, and one species only. A failure to obtain these conditions has been responsible for many of the con-

* Sinton, J. A., and Mulligan, H. W., *Rec. Mal. Survey India*, 1932, 1933 A, **3**, 357–414 ; 1933 B, **3**, 719–808.

tradictory statements which have crept into the literature on monkey malaria.

The older literature on the morphology of the Plasmodia of the lower monkeys was in a chaotic condition. This was partly due to the meagre descriptions given by some of the earlier workers of the parasites observed by them. It appears also to have been influenced largely by the fact that mixed infections with two or more species of *Plasmodium* are not rare in these animals, at least among the Oriental *Cercopithecidæ*. Many of the descriptions recorded appear to refer to two different species of parasite, which were present in the same host, but this condition was neither recognised nor suspected.

Sinton and Mulligan have carefully reviewed the literature on the Plasmodia of the lower monkeys. These workers made a special study of the malarial parasites found in the blood of the Oriental monkey, *S. irus* (*Macacus cynomolgus*; *Pithecus fascicularis*), the crab-eating monkey of Malaya and Burma. Individuals of this species of monkey are not uncommonly infected with malaria, but unfortunately these infections are not infrequently due to two or more species of parasite. The fact that such mixed infections were unsuspected, has given rise to much confusion in the descriptions of the Plasmodia infecting this species of monkey.

The first malarial parasite to be described from the lower Oriental monkeys was *Plasmodium inui* Halberstadter and Prowazek, 1907, from the blood of specimens of *S. irus* from Java and of *S. nemistrinus* from Sumatra. A few months later a new species *P. cynomolgi* Mayer, 1907, was recorded from an infection in *S. irus*, also from Java. Many observers consider that the latter species is identical with the former. Sinton and Mulligan, however, thought that *P. cynomolgi* was probably a distinct species, but placed it provisionally as a variety of *P. inui*. The reason for this was that, while they had had ample opportunity of studying *P. cynomolgi*, both in natural and in experimental infections, yet they had to depend for information about *P. inui* on descriptions given by other workers. As will be seen later, their views as to the specific identity of *P. cynomolgi* have since been confirmed.

Sinton and Mulligan proved that mixed plasmodial infections were not uncommon in *S. irus* in nature, and they managed to separate from the blood of this monkey two distinct species of *Plasmodium*. These parasites they identified as *P. inui* var. *Cynomolgi* Mayer, 1907, and a new species, *P. knowlesi* Sinton and Mulligan, 1932.

*Plasmodium knowlesi* does not appear to be very closely related to any of the three common malarial parasites of man, although it shows some morphological characters resembling each of these. This species was proved to have an asexual cycle of 24 hours' duration. While infection with this parasite has apparently little clinical effect on its natural host, *S. irus*, it produces quite a different picture when a susceptible host, such as *S. rhesus*, is infected experimentally with it. In the latter species of monkey, it causes very severe symptoms, often hæmoglobinuria, and almost invariably produces death with pernicious symptoms, if the infection be untreated. Knowles and Das Gupta have managed to transmit this infection to man by blood inoculation.

*Plasmodium cynomolgi* very closely resembles in its morphology *P. vivax*, the benign tertian parasite of man. It has a 48-hour asexual cycle. The clinical symptoms produced in *S. irus* and in *S rhesus* are of a mild character. This infection has been transmitted experimentally from monkey to monkey by the bites of infected specimens of *Anopheles annularis* and *A. subpictus*.

Since Sinton and Mulligan recorded these two species of *Plasmodium* from *S. irus*, a third species has been detected in their laboratories from the same species of natural host. The infection was also a mixed one originally, but a pure infection has now been isolated experimentally in *S. rhesus*. This parasite appears to be identical with *P. inui* sens. restr., as described by Halberstadter and Prowazek and by Mathis and Leger.

The morphology of this parasite has several points of resemblance to *P. malariæ*, the quartan parasite of man, but some forms more closely resemble *P. vivax*. The infection produces mild effects in *S. irus* and in *S. rhesus* and tends to be very chronic. The duration of the asexual cycle of *P. inui* sens. restr. was usually said to be 48 hours, but the evidence in support of this statement was very unsatisfactory. A careful study of long series of blood films taken every few hours from monkeys infected with this third parasite, shows that its asexual cycle has a periodicity of 72 hours.

These findings prove definitely that three species of *Plasmodium* occur naturally in the blood of the Oriental monkey, *S. irus* from Malaya, namely:—

(*a*) *P. knowlesi* Sinton and Mulligan, 1932, having a 24-hour asexual cycle;

(*b*) *P. cynomolgi* Mayer, 1907, having a 48-hour asexual cycle; and

(*c*) *P. inui* Halberstadter and Prowazek, 1907, having a 72-hour asexual cycle.

All these species are easily transmissible by blood inoculation to *S. rhesus*, and pure infections are being maintained in the laboratories of the Malaria Survey of India, Kasauli.

The facts (*a*) that the common brown monkey of Northern India (*S. rhesus*) is susceptible to experimental infection with these three species of simian Plasmodia, (*b*) that these monkeys appear to have no malarial infection in nature, and (*c*) that they are easily and cheaply available in India, open up a wide field in this country for the investigation of many important malaria problems. Such facilities are available in few or no other countries of the world.

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# Permeability of Protoplasm—A Probable Factor in Transpiration.

## (Being a Study of Transpiration Response under Ultra-Violet Radiation.)

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Of the various factors that appear to control transpiration it is the atmospheric ones which have received by far the greatest attention and much stress has been laid to show that transpiration is a relatively simple process, probably the simplest of all the plant functions yet known, governed largely by the environic complex. The behaviour of transpirational loss of water under controlled environment, however, has led Plant Ecologists to believe that there exist some internal factor or factors in transpiration, the nature of which does not seem to be well understood.

The present brief note is an outcome of some observations on the influence of ultra-violet radiation upon transpiration, and when taken in conjunction with an independent parallel study on permeability in plant tissues, seems to provide repeated conclusions of an uncommon interest, revealing that protoplasmic permeability performs a regulatory function in transpiration.

While investigations relating to the influence of ultra-violet radiation are known to exist, in an incomplete form though, upon such individual functions as photosynthesis, respiration and permeability in plants, to our knowledge, no observations appear to have been made so far as to the influence of such rays upon transpiration. The observations herein recorded are an attempt in this direction.

The procedure of experimentation in brief consists in selecting healthy mature cut twigs of *Cajanus indicus*, *Triticum vulgaris* and *Andropogan sorghum*, fixing them in hermetically sealed glass vessels containing sufficient water in which the cut end always dips, and estimating the hourly loss of water after the method already described elsewhere.[1] The experimental material is subjected to desired doses of 0, 5, 10, 15, 20, 30 and 40 minutes exposure to ultra-violet radiation.

On plotting the mean transpiration values for the treated plants obtained for a period of five successive hours against time (Fig. 1) it is noticed that the general nature of the response in all the three cases under consideration is similar in spite of material differences. We shall, therefore, try to explain the phenomenon on the basis of the data obtained for any one crop.

A reference to Fig. 2 would indicate that transpiration of irradiated plants exhibits two maxima, one under ten minutes treatment while the other under thirty minutes exposure. Both these pitches are preceded and followed by a decline in the transpiration curve which, in general, shows an unusual contrast to the curves of transpiration obtained for the control plants.

The increase or decrease in the rate of transpiration of treated plants as against the control, may be explained on the basis of certain imminent possibilities:—

(i) Variation in the supply of water from the roots.

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[1] Singh, B. N., "On the Use of Bates Evaporimeter and Evaporimeters in general in Studies on Plant Transpiration," *Journ. Ind. Bot. Soc.*, 1924.

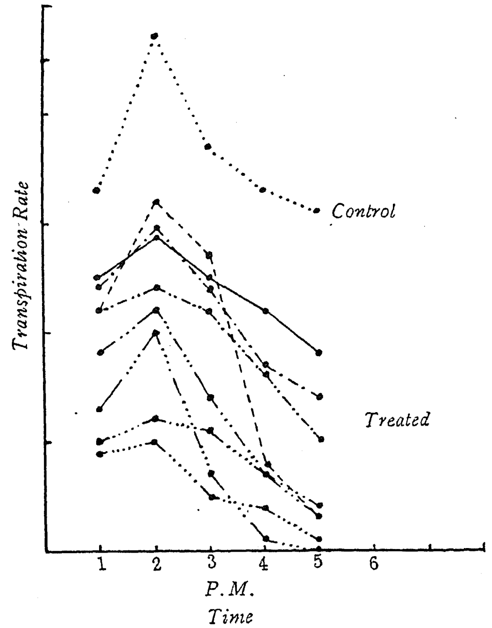


**Fig. 1.**

Showing Transpiration Rate of Cut Shoots of *Cajanus Indicus* with March of Time.

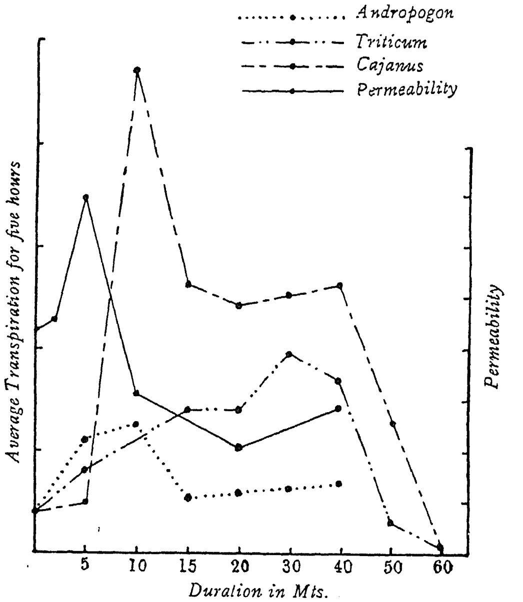


**Fig. 2.**

Showing Transpiration Rates and Permeability in Plants.

(ii) Variation in the stomatal aperture.
(iii) Changes in the leaf water-content.

The question of a deficiency of water supply should not ordinarily arise as in order to eliminate the root factor, experiments are conducted on cut shoots, with the cut ends dipping under water where a constant supply of the same is always available well above the requirements of the shoots. The experiments being conducted under moderate environmental conditions, the absorption from the roots is not expected to fall short of the demand of water made by the transpiring leaves.

For ascertaining how far transpiration is affected by the degree of stomatal opening in plants treated with varying doses of irradiation, comparative values of the average stomatal area and transpiration rate are obtained and portrayed below :—

| Irradiation period in minutes | Tn. rate relative to tn. in control | Average area of stomatal opening size × 750 |
|---|---|---|
| 0 | 1·00 | 0·28 |
| 5 | 1·04 | 0·28 |
| 10 | 2·75 | 0·28 |
| 15 | 1·90 | 0·26 |
| 20 | 1·82 | 0·26 |
| 30 | 1·90 | 0·41 |
| 40 | 0·87 | 0·28 |

A glance at the values indicates that there exists no proportionality between the degree of stomatal opening and transpiration. The stomatal area remains unchanged for control and 5, 10 and 40 min. irradiation and shows small closing in case of 15 min. exposure and a marked opening at 30 min. Thus against both the maximum and minimum transpiration values for 10 and 40 minutes treatment respectively, the stomatal aperture remains unchanged. The maximum and minimum stomatal aperture also signifies no correlation whatsoever with the corresponding values of transpiration. Repeated observations as to the relation between stomatal opening and transpiration go to confirm the above conclusion, a fact further supported by the detailed work of Loftfield[2] on stomatal regulation where he has shown that widely open stomata, as is found in the present case, possess no control over the amount of water loss. In a more detailed study Singh and Sudame[3] have

[2] Loftfield, J. W. G., "The Behaviour of Stomata," *Carn. Inst. Wash. Pub.*, 314.

[3] Singh, B. N., and Sudame, M. M., "Size of Stomatal Chamber and Pore Diameter and their Role in the Regulation of Transpiration," (*In course of publication.*)

shown that the size of the stomatal chamber and the pore diameter seem to possess little control over transpiration, thus emphasising the view put forth above.

Barring the influence of stomata and deficiency in water supply, the explanation for an increase in the rate of transpiration must be sought elsewhere. As to the regulatory influence of leaf water-content, in a recent study Singh and Singh[4] have shown that the rate of transpiration is more or less independent of the leaf water-content and is to a large extent governed by absorption of water. But in the present experiments, as has already been indicated, limitations due to absorption did not arise.

How are we, then, to account for the variation in the transpiration rate? In this connection attention may be drawn to a separate work from this Institute upon the effect of ultra-violet radiation on the permeability of protoplasm[5,6] where an initial increase with increasing dose constitutes the first maximum followed by a second one after an intervening period of decline (Fig. 2).

The general similarity in the nature of the curves for permeability and transpiration following irradiation is indeed most characteristic and leads one to the conclusion that in the absence of the operation of the other controlling factors discussed above, increased or decreased transpiration may well be explained on the basis of permeability changes in the protoplasm of mesophyll cells.

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# The Study of Plant Tissue Fluids. A Critical Review.*

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### PRESERVATION OF TISSUE FLUIDS.

THE tissue fluids thus obtained cannot be preserved even at low temperatures (0°C) without appreciable changes occurring in the fluid, the most prominent change being the precipitation of proteins through gradual coagulation. Gooke[38] has shown that, in the case of tissues, low temperatures induce an intramolecular change in the tissue proteins which leads to their denaturation; this circumstance has been correlated with winter-hardiness in plants. The coagulum adsorbs many essential constituents, particularly enzymes and viruses. Duggar[39] has found that the mosaic of tomato is not seed borne and opines that the seed proteins adsorb the virus. The failure to transmit many of the viruses through artificial injection of sap, as in the case of the spike-disease of sandal, is probably due to the circumstance that the virus gets adsorbed by the associated proteins during the preparation of the sap. In such cases, it is necessary to carry out the extraction with various buffers and the one which elutes the essential constituent chosen.

A similar procedure should be adopted for the study of enzymes on account of their analogous behaviour. The protein coagulation is influenced by tannins which in the case of certain enzymes like diastases are known to exert an inhibiting or inactivating influence. The effect of tannins and allied substances on the virulence of plant viruses has not been investigated. The extraction of sap from tannin-bearing tissues for certain enzyme studies, is best accomplished by adding hide powder during mincing and grinding. In their studies on the diastatic activity of the diseased and healthy sandal leaves, the authors have adopted this procedure. For the investigation of special constituents, certain modifications in technique have therefore to be introduced, and it is difficult to recommend any one general procedure for universal adoption.

For a study of the infectivity of viruliferous tissue fluids or for determining the resistance offered by tissue fluids to the growth of certain pathogens, the fluid should be obtained under aseptic conditions as it does not permit of heat sterilization.

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[4] Singh, B. N., and Singh, R. B., "The Relative Efficiency of Leaf Water-Content and Absorption in Transpiration." (*In course of publication.*)

* Continued from *Curr. Sci.*, 1934, **3**, 8.

[38] Gooke, *C. A.*, 1907, **1**, 196.

[39] Duggar, *J. Bact.*, 1930, **19**, 20.

[5] Singh, B. N., and Chakravarty, S. C., "Effect of Ultra-violet Rays on the Permeability of Protoplasm of *Trapa bispinosa* to Ions." (*In course of publication.*)

[6] Singh, B. N., and Sheshagiri, P. V. V., "Effect of Ultra-violet Rays on the Permeability of Protoplasm of Storage Tissues to Ions." (*In course of publication.*)

A convenient method for obtaining sterile fluids has been described by Ranker.[40]

### METHODS OF INVESTIGATION AND THEIR CHOICE.

Tissue fluid studies may be classified into three broad divisions: (1) Physico-chemical; (2) Chemical, and (3) Biochemical. Physico-chemical methods include determinations of density, refractive index, depression of freezing point, electrical conductivity, hydrogen-ion-concentration, buffer values, optical activity, oxidation-reduction potential, temperature of coagulation, etc. Chemical methods are employed for an estimation of total solids, ash and ash constituents, total and amino nitrogens, carbohydrates and sugar alcohols, volatile and gaseous constituents like hydrogen cyanide, aldehydes and carbon dioxide, chlorophyll and other pigments, glycosides, alkaloids, tannins, fats and lipoids. Biochemical and biological methods are invoked for a study of the enzyme make-up of a fluid or a determination of the infectivity of a virus-bearing sap, or for an estimation of certain constituents like sucrose, maltose, inulin, glycosides, which are attacked by specific enzymes.

The choice and adoption of a particular method depends upon the nature of the problem, the accuracy required and the rapidity and frequency with which the samples have to be analysed. Generally, for the investigation of a given problem, one is rarely called upon to estimate all the constituents or conduct all physico-chemical measurements.

Physico-chemical methods are, in general, more elegant, less cumbersome, possess greater ease of reproducibility, require smaller quantities of samples and are conducted with greater rapidity and accuracy. In many of the measurements like the determination of the depression of the freezing point and electrical conductivity, the chemical composition of the tissue fluid is not affected, and the same aliquot of the fluid usually suffices for a few of the other determinations, thus effecting great economy in the use of research material. Wherever possible physico-chemical methods should be preferred to chemical methods.

Chemical methods, indispensable for the determination of certain constituents, require appreciable amounts of tissue fluid for analysis. The quantity required depends upon the concentration of the constituent in question and the sensitiveness of the method employed for its determination. Micro methods, if adopted, economise the material, and their application to the study of tissue fluids offers a wide and fruitful line of research. Animal physiologists have attained great distinction in this line, many of whose methods can be adopted in these studies.

Biochemical methods are characterised by the great specificity of their reactions which render the estimation of certain constituents infallible, and in certain cases they are the only methods available. An estimation of a glucoside, maltose and sucrose in a mixture, for example, is best accomplished with the aid of suitable enzyme reagents free from interfering enzymes.

### PHYSICO-CHEMICAL MEASUREMENTS AND THEIR SIGNIFICANCE.

A. *Density.*—Density, determined pyknometrically, has been found useful in evaluating the solid content of the tissue fluids of a plant at various phases of its growth. The measurement does not influence the composition of the fluid in any manner and requires 5—10 c.c. of the fluid.

Density measurements have revealed that rapid growth is accompanied by lower concentrations while a dormant condition induces higher concentration of solutes in sap;[37,41,42] so does production of fruit.[43] Density is influenced by soil moisture[44,45] and by other factors of habitat of the plant.[41,45] Aquatic plants generally have a sap of low density. An idea of the water requirement of a crop or plant can be obtained by a determination of the density of its tissue fluids; the density is inversely proportional to their water requirements.[44] No relationship seems to have been observed between winter hardiness and density.[9,12] Determinations of density form a routine procedure in the chemical control of certain industries such as sugar, fruit syrups, etc.

Sap concentration is affected by the onset of diseases. Corn stalks affected by smut,[46] tissues from spiked sandal plants,[47] and

[40] Ranker, *Phytopathology*, 1930, **20**, 569.

[41] Reed, *J. Agr. Res.*, 1921, **21**, 81.

[42] Reed and Halma, *J. Agr. Res.*, 1926, **32**, 1177.

[43] Webber, *C. A.*, 1921, **15**, 3131.

[44] Eaton, *Amer. J. Bot.*, 1927, **14**, 212.

[45] Bates, *J. Agr. Res.*, 1923, **24**, 131.

[46] Karrer, *Amer. J. Bot.*, 1926, **13**, 286.

[47] Iyengar, *J. Indian Inst. Sci.*, 1929, **12A**, 295.

tumourous growths comprising proliferous tissue[48] yield fluids of a lower concentration than the corresponding healthy tissues.

A fluid of higher density is obtained from shoots attacked by lac insects.[33]

B. *Refractive Index.*—Refractive index[49] offers a quick method of evaluating the total solids in a given sap and requires just a drop of the fluid, and has been extensively employed both in physiological research and in commercial practice, in estimating the sucrose content of cane juices.

C. *Depression of the Freezing Point,* $\triangle$—*Osmotic Pressure.*—Depression of the freezing point is proportional to the total concentration of the osmotically active constituents of the sap, and gives a measure of its osmotic pressure. Dixon and his co-workers have employed this method in connection with their studies on the ascent of sap in plants.[50] The method has been adopted for elucidating the osmotic relations between hosts and parasites,[18,51] for understanding the nature of draught resistance[52] and winter-hardiness,[6,53,54,55] for a study of the changes accompanying the vegetative growth, fruiting and maturation of crops,[56,57,58,59] for obtaining an insight into the response of plants to changes of environment[2,60,61,62,63,64,65,66,67] and treatment, and for a study of pathological changes induced in the plant with the onset of physiological and parasitic diseases.[68,69]

About 5 c.c. of the tissue fluid suffice for a determination by Beckmann's cryoscopic method, but by Dixon's thermoelectric method,[70] the quantity can be reduced to 2 c.c. Still smaller quantities, (0·1 or 0·2 c.c.) can be employed for the determination by the "melting point method"; the liquid is placed in a capillary tube attached to a Beckmann's thermometer, and the freezing point determined by the disappearance of the liquid meniscus observed with a reading telescope.[71]

Factors which increase the concentration of crystalloids in the tissue fluids of an organism, are those which contribute towards a greater depression of the freezing point. Increased photosynthet'c activity under the stimulus of light or artificial illumination, results in a concentration of sugars[72]; increased absorption of soil nutrients results in a corresponding enhancement of the inorganic constituents in the tissue fluids, particularly in the roots.[73] Conditions which favour transpiration also lead to a concentration of crystalloidal constituents of the sap and increase its osmotic pressure.

Minced tissue is often employed for the depression of the freezing point but the method yields higher values.[74]

Among the other methods of determining osmotic pressure are (1) the plasmolytic method, and (2) the drop method of Barger.[75] The relative merits of the plasmolytic and cryscopic methods have been discussed by Atkins.[76]

Mention may also be made of another term $O_g$—Osmotic value often employed and is defined as the molal concentration of cane sugar, which is necessary to effect

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48 Harris and Gortner, *Biochem. Bull.*, 1915, **4**, 52.

49 Gortner and Hoffman, *Bot. Gaz.*, 1922, **74**, 308.

50 Dixon, *Transpiration and Ascent of Saps in Plants* (Macmillan & Co., Ltd.), 1914.

51 Harris, *C. A*, 1919, **13**, 2898.

52 Harris and Henry, *Hawaiin Planters Rec.*, 1930, **34**, 167.

53 Sutherst, *Chem. News*, 1901, **84**, 234.

54 Gail, *Bot. Gaz.*, 1926, **81**, 434.

55 Maximov, Krasnosalskaia—Maximova, *Physiol. Abs.*, 1919, **4**, 413.

56 Dixon and Atkins, *Sci. Proc. Roy. Dub. Soc.*, 1912, **13**, 219.

57 Gail and Cone, *Bot. Gaz.*, 1930, **88**, 437.

58 Lutman, *Amer. J. Bot.*, 1919, **6**, 181.

59 Harris, Gortner and Laurence, *Physiol. Abs.*, **2**, 436.

60 Drabble and Drabble, *Biochem. J.*, 1907, **2**, 117.

61 Harris, Laurence and Gortner, *Physiol. Rev.*, 1916, **2**, 1.

62 Fitting, *C. A.*, 1912, **6**, 766.

63 Hector, *C. A.*, 1928, **22**, 3723.

64 Blagoveshchenskii, Bogobyubova and Chernova, *C. A.*, 1928, **22**, 2590.

65 Arrhenius, *C. A.*, 1920, **14**, 2358.

66 Harris, *Amer. J. Bot.*, 1918, **5**, 490.

67 Harris and Laurence, *Bot. Gaz.*, 1917, **64**, 285.

68 Sprecker, *Physiol. Abs.*, **2**, 649.

69 Iyengar, *J. Indian Inst. Sci.*, 1928, **11A**, 103.

70 Dixon and Atkins, *Sci. Proc. Roy. Dub. Soc.*, 1910, **12**, 275.

71 Drucker and Schreiner, *Biol. Zbl.*, 1913, **33**, 99.

72 Dixon and Atkins, *Sci. Proc. Roy. Dub. Soc.*, 1916, **15**, 51.

73 McCool and Millar, *Soil Sci.*, 1920, **9**, 217.

74 Bouyoucos and McCool, *J. Amer. Soc. Agr.*, 1916, **8**, 50.

75 Barger, *J. C. S.*, 1904, **85**, 286.

76 Atkins, *Sci. Progress*, 1917, **11**, 562.

incipient plasmolysis.[77,78] The variation of Og serves as an index of the physiological activities of the tissue.

D. *Electrical Conductivity, K.*—The electrical conductivity of a sap is a measure of the total electrolytes present in a sap.[79] The depression of freezing point accounts for the crystalloids—both electrolytes, and non-electrolytes. From a knowledge of these two values, the concentration of non-electrolytes can be calculated and expressed in terms of cane sugar.

Conductivity measurements could be made with very small quantities of liquids—about 1 c.c. There is no particular advantage in using larger quantities. The choice of the conductivity cell depends upon the conductivity of the liquids; generally speaking for the investigation of physiological fluids, Arrhenius-Ostwald conductivity cell has been found convenient. The cell is provided with three sets of dip electrodes, differing from one another in the distance between the electrodes. In the case of tissue fluids with low conductivity, the one with the electrodes close to each other is employed.

Poisoning of the electrodes with the proteins of the sap is a common experience. To obtain reliable results, frequent platinising of the electrodes is necessary.

Conductivity determinations coupled with those of the depression of the freezing point, give useful information regarding the origin of osmotic forces in plants which may arise from two or more independent sources. Absorption of soil nutrients[80] and metabolic processes favouring the formation of organic acids, contribute towards conductivity, while an increase in photosynthetic sugars merely enhances the concentration of non-electrolyte crystalloids.

Conductivity measurements are affected by the viscosity[81] and in the case of mucilaginous saps, the effect may be appreciable. The suppression of dissociation due to the mutual action of salts and acids[79] also affects the results for the total electrolyte content through conductivity measurement. A rough relationship has been found to exist between conductivity and inorganic constituents of saps as determined by ash content, and for most purposes the conductivity may be taken as a rough estimate of the ash content of the tissue fluids.

E. *H-ion Concentration and Buffering Capacity of Tissue Fluids.*—There is a vast amount of literature on this aspect of plant physiology. The importance of hydrogen-ions as a regulating mechanism for many of the vital processes of plants, has long been recognised and a large number of methods have been developed for its determination. The usual methods consist in measuring the potential of a hydrogen electrode dipping in the sap against the standard calomel electrode. The hydrogen electrode can be replaced by quinhydrone, antimony or other electrodes. An elegant glass electrode suitable for working with a few drops of tissue fluid has been described.[81] The quantity of fluid necessary for the determination depends upon the apparatus employed; 3-5 c.c. are required for Clark's electrode.[82] Haas[83] describes an electrode vessel suitable for work with 3 to 4 drops of plant juice. With the modified micro-electrode of Bodine and Fink,[84] the quantity may be reduced to 0·25 c.c. to 0·01 c.c. depending upon the size of the electrode vessel. The latter can function either as a hydrogen or quinhydrone electrode. Further refinement has been secured by Taylor and Whittaker[85] who succeeded in constructing a micro-non-polarisable electrode which can be used for determining the hydrogen-ion concentration of living cells and tissues, with great accuracy. The capillary electrode devised by Robertson and Smith[86] is suitable for measurement of pH at a point *in situ* of the plant tissue, and can therefore be employed for surveying the pH values at various points of an organ, and also in such of those cases, where the tissues during pulping suffer chemical transformations leading to an alteration in the pH values.

Hydrogen-ion concentration in the cell sap without expression from the cell has been

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77 Beck, *Plant Physiology*, 1928, **3**, 413.
78 Beck, *Ibid.*, 1931, **6**, 315.
79 Haynes, *Biochem. J.*, 1919, **13**, 111.
80 Hoagland, *Bot. Gaz.*, 1919, **18**, 297.
81 MacInnes and Doll, *J. Gen. Physiol.*, 1929, **12**, 805.
82 Clevenger, *Soil Science*, 1919, **8**, 217.
83 Haas, *Soil Science*, 1920, **9**, 341.
84 Brunstetter and Magoon, *Plant Physiol.*, 1930, **5**, 249.
85 Taylor and Whittaker, *Protoplasma*, 1928, **3**, 1.
86 Robertson and Smith, *J. Soc. Chem. Ind.*, 1930, **49**, 120.

measured both electrometrically and colorimetrically. Such *in vivo* studies of the properties of the cell sap represent a great improvement over the *in vitro* study of saps and there is a fruitful field in this line for developing the *in vivo* technique for elucidating the nature of the cell sap. Mention may also be made of the Range Indicator Method by Small and his co-workers[87,88,89] which has proved invaluable in studying the reaction of individual cells and their variations due to seasonal factors.

For rapid work, particularly field work, colorimetric methods are available, where a series of indicators, each measuring a different range of hydrogen-ion concentration, are employed. For coloured solutions the method is unsuitable. Further the colorimetric method is affected by the 'salt' and 'protein' errors and does not yield accurate results. Arland[90] has carried out comparative studies of the potentiometric and colorimetric methods. Domontvich[91] finds fair agreement between hydrogen and quinhydrone electrodes.

The simple quinhydrone electrode is unsuitable to saps not because of the 'salt' error which is negligible with the concentration of salts obtained in the tissue fluids, but is due to the presence of sugars and phosphates. Billmann and Katagiri[92] have shown that the use of the hydroquinhydrone electrode gives reliable values.

The concentration and reaction of the nutrient solution in which the plant thrives does not greatly influence the hydrogen-ion concentration of the sap[93] but the root sap responds to the soil acidity and builds up a buffering mechanism to withstand the adverse effects of soil reaction. The buffering capacity is influenced by ions—potassium and phosphorus enhancing and calcium and chlorine lowering the capacity.[21] A marked diurnal variation[94] in the hydrogen-ion concentration has been observed, not to speak of the seasonal and regional fluctuations.[87] The external factors appear to influence only the outer cells of the plants and the inner cells enjoy a greater uniformity with respect to the hydrogen-ion concentration. There is a gradient in the pH from the top to the root.[95] Application of fertilizers like potash and phosphate tends to increase and nitrogenous manures decrease the pH.[96]

The effect of $CO_2$ produced as a result of respiration, on the buffering of the living cells deserves extended investigation. Instances are known where the $CO_2$ content may be as high as 20–30 per cent.[97] The $CO_2$ balance in a plant sap is comparatively little investigated. Our knowledge on the subject is mainly due to the work of Ingold,[98] Willman and Brown,[99] Small[100] and others. The extent to which $CO_2$ exists in the dissolved condition is important in the photosynthetic activity of the plants.

The methods of identification of plant acids have been investigated by Czapeck.[101] More recently Iyengar[102] has examined the acids in the tissues of healthy and spiked sandal plants. The acidity changes are particularly marked when the physiological state of the plant is upset by the entry of parasites through adverse environmental conditions. Reduced root activity due to phylloxera attack on vines lead to high acidity of plant saps.[14] The stem weevil attack of cotton leads to an increase in alkalinity.[103] In cases of tumour growth and proliferous tissue there is a decrease in hydrogen-ion concentration.[104] Disease resistance in grape vines[14] is characterised by a high acidity, a low sugar content, and a poor oxidase activity. In the case of the tobacco root rot it has been found that low soil acidity favours the incidence of disease. The subject has been investigated by Morgan and others.[105]

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87 Rear and Small, *Protoplasma*, 1927, **2**, 428.

88 Ingold and Small, *Protoplasma*, 1928, **3**, 458.

89 Small, "Hydrogen-ion concentration in plant cells and tissues," *Verlag von Gubruder Borntraeger, Berlin*, 1929.

90 Arland, *C. A.*, 1925, **19**, 2225.

91 Domontvich, *C. A.*, 1927, **21**, 3217.

92 Billmann and Katagiri, *Biochem. J.*, 1927, **21**, 441.

93 Arrhenius, *Physiol. Abs.*, 1922, **8**, 375.

94 Truog and Meacham, *Soil Science*, 1919, **7**, 469.

95 Gustafson, *Amer. J. Bot.*, 1924, **11**, 1.

96 Miyake and Arachi, *J. Biochem.* (Japan), 1924, **4**, 317.

97 Magness, *Bot. Gaz.*, 1920, p. 308.

98 Ingold, *Protoplasma*, 1930, **9**, 456.

99 Willman and Brown, *Plant Physiology*, 1930, **5**, 535.

100 Small, *New Phytologist*, 1920, **50**, 19.

101 Czapeck, *Biochemie der Pflanzen*, 1923, **3**, 99.

102 Iyengar, *J. Indian Inst. Sci.*, 1933, **16A**, 139.

103 Lakshmana Rao, *Madras Agr. Dept. Year Book*, 1926, p. 65.

104 Harvey, *Amer. J. Bot.*, 1920, **7**, 211.

105 Morgan, Anderson and Dorsey, *Connecticut Agr. Exptl. Stn. Bull.*, 1929, No. 306.

The buffering capacity of a particular fluid is connected with its chemical make-up, which consists mainly of organic acids, their salts, and phosphates.[106-109] This has been amply demonstrated in a number of plant juices. In fact, the salt content of a juice can be determined with a fair degree of accuracy through a determination of the pH and titratable acidity and referring to a table showing the relationship between titratable acidity and pH of related artificial buffer mixtures.[110] Proteins play a negligible rôle in the buffering systems. This is not surprising as a consideration of the basis of the buffering capacity will show that it is an ionic phenomenon and the proteins possess a large molecular weight.

The buffer index $\beta$ is equal to $\frac{dB}{dpH}$ where $dB$ is the gramme-equivalent concentration *per litre* of added base and $d$pH is the observed change in the pH when the quantity $dB$ is added to the solution when buffer index is being determined. The introduction of the conception of the buffer index[111] has largely served to clarify our conceptions regarding buffers.

The midrib and petiole sap of a leaf has less buffer effect compared with that derived from the rest of the leaf. In the intact cell, the cell wall itself resists the change in acidity of the cell contents due to external $H^+$ or $OH^-$ and thus acts as a buffer. This was demonstrated in the case of *Nitella* by Hoagland and Davis.[112]

Buffers offer a fine mechanism through which the hydrogen-ion concentration is maintained at a particular optimum. On account of this mechanism, the reaction of plant cells is not affected by fluctuations in the reaction of soil medium, by the violent metabolic disturbances caused by the invasion of parasitic organisms or changes of environment. In fact the buffering capacity has been considered to be a measure of disease resistance.

Glycerine, sugars and alcohols increase the dissociation of acids and therefore act as negative buffers,[113] and an abnormal accumulation of these products always renders the plant susceptible to fungus infection.

*Other Physico-Chemical Measurements.*—There is little literature regarding a study of viscosity or surface tension of plant saps. A determination of the viscosity of saps would provide useful data for obtaining an idea of the hydrophillic colloid content and perhaps throw some light on the ascent of sap in plants.

The optical activity of a plant sap is not usually determined since the concentration of the optically active constituents in the sap are generally small except in special instances like cane juice, when this method is extremely valuable in assaying the sucrose content. Further, the method is not directly applicable to the great majority of plant tissue fluids which, being coloured, have to be treated with clarifying agents before a determination can be carried out. The method is no doubt a valuable one which merits a wider employment and should be extended to a determination of the exaltation in optical activity after addition of borates or arsenates. This will differentiate hydroxy compounds, *e.g.*, sugar alcohols like mannitol and organic acids like tartaric. If an appreciable exaltation is obtained, the presence of such or related compounds should be suspected.

*Physico-Chemical Data: Their Interrelationships and Interpretations.*—The depression of the freezing point is a measure of the total concentration of the osmotically active substances in solution, which include, not only the crystalloids in true solution but also the colloidal micelle with different osmotic valencies. The conductivity measurements give an idea of the total concentration of the electrolytes and the colloidal micelle carrying ionic charges. The non-electrolytes like sugars and the colloidal micellæ which do not carry any effective charge but which are osmotically active do not contribute towards the electrical conductivity of the solution. If therefore we have the depression of the freezing point, $\triangle$, and the electrical conductivity K, we can obtain a ratio of the two values $\frac{K}{\triangle}$ which indicates changes in relative concentration of ions in relation to total solutes. This ratio has been determined in a great number

106 Martin, *Protoplasma*, 1928, **3**, 273.

107 Martin, *Ibid.*, 1928, **3**, 282.

108 Ingold, *Ibid.*, 1929, **6**, 51.

109 Ingold, *Ibid.*, 1930, **9**, 447.

110 Haynes and Brown, *Biochem. J.*, 1928, **22**, 947.

111 Van Slyke, *J. Biol. Chem.*, 1922, **52**, 525.

112 Hoagland and Davis, T., *Gen. Physiol.*, 1923, **5**, 629.

113 Lenthardt, *Kolloidchem. Beihefte.*, 1927, **25**, 1.

of investigations. In the case of the sandal leaves, the ratio is lower in spiked sap than in normal material; on the other hand, the sap derived from shoots attacked by lac insects has been found to possess a higher ratio.

The average molecular weight of the solutes can be computed from (1) the total solids of the sap (C) and (2) depression of the freezing point, $\Delta$.

$$M = C. \frac{K}{\Delta}$$

where K=1000 × molecular lowering for a given solvent.

It has been found that host plants of lac reputed to yield thick encrustations of lac, contain a sap whose solutes have a high average molecular weight, indicating the existence of high molecular compounds favouring the production of resin. The tissue fluids of the sandal leaf in the diseased condition contain solutes whose average molecular weight is low and indicate a disintegration of the high molecular proteins. It should be possible to make a further differentiation between the mean molecular weight of the electrolytes and that of the non-electrolytes in the sap, by taking into consideration the data for electrical conductivity. An attempt in this direction may lead to significant results.

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## Obituary.

### Reverend Ethelbert Blatter, S.J. (1877—1934).

REVEREND FATHER ETHELBERT BLATTER was born at Rebstein in Switzerland on the 15th September 1877. He received his early education at the Benedictine School at Sarnen in Unterwalden and later at Schwyz where he devoted himself to the study of modern languages. He joined the Society of Jesus on the 15th October 1896. This step caused great surprise among his numerous friends and relatives, for to them it seemed well-nigh unbelievable that the boisterous jovial, well-to-do lad they had known should decide to be one of the Jesuits. After completing his studies in Philosophy, he applied himself almost exclusively to the study of Botany. He came out to India in 1903 as Professor of Biology at St. Xavier's College, Bombay. After a stay of six years in India he went back to Europe in 1909 to complete his ecclesiastical studies and was finally ordained a priest on the 25th August 1912. On his return to Bombay in 1915 he once more took up work as Professor of Biology at St. Xavier's College of which he later became the Principal in 1919. In 1925 Father Blatter retired from his professorial duties to Panchgani where he remained till almost the end of his life. He passed away peacefully on the 20th May 1934 at St. Vincent's High School, at Poona.

From the period of his arrival in India in 1903 dates the commencement of a stream of publications in Botany which continued until his death. Father Blatter devoted his time and energy to the study of the Asian flora. He travelled extensively and made large collections which formed the basis of his writings. His most important contribution between 1903 and 1909 was the "Palms of British India and Ceylon" published later in book form by the Oxford University Press. While in London he compiled "the Flora of Aden" and "the Flora of Arabia". With all the material he was collecting he built up a fine Herbarium which is now in St. Xavier's College. In 1926 he undertook to revise the "Flora of the Bombay Presidency" first published by Cooke. Twenty-one parts of this work have already been published. Among his other important publications, some of which are in collaboration with other workers, are "the Flora of the Indus Delta" "the Flora of Beluchistan," "the Flora of Waziristan," "the Ferns of Bombay," and "the Flowers of Kashmir". A monograph on "the Bombay Grasses" by Blatter and McCann is in course of publication.

He served the Bombay University in many capacities as a member of the Senate, the Syndicate and the Science Faculty, and he had much to do with the present University Reforms. He was the Vice-President of the Bombay Natural History Society and gave of his best to that Society. He was elected President of the Botany Section of the Indian Science Congress in 1926 and the President of the Indian Botanical Society in 1927.

In recognition of his work in Botany Fr. Blatter was awarded the Johannes Bruehl Memorial Medal for the year 1931. It was

a fitting tribute to his pioneer work on Asian Flora.

As a man Father Blatter was kind-hearted and generous, full of wit and humour, which never forsook him even under the most trying conditions of his health. His life was a selfless one, true to his calling as a Jesuit and to the science he loved. His premature death is a great loss to the science of Botany to which he rendered outstanding services.

R. H. D.

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### Professor P. Sampat Iyengar, M.A.

It is with deep regret that we record the premature death, on Tuesday, 24th July 1934, of Mr. P. Sampat Iyengar, retired Director-Professor of Geology in Mysore, at the early age of 55.

As an officer of the Mysore Geological Department for nearly thirty years, Mr. Sampat Iyengar published numerous important papers in the Records of the Department, and was largely responsible for formulating many of the fundamental ideas regarding the Geology of Mysore which are even to-day guiding the work and shaping the policy of the Mysore Geological Department. His address on "The Acid Rocks of Mysore" from the Presidential Chair of the Geology Section of the Indian Science Congress (Nagpur 1920) still stands as a valuable and authoritative statement on this aspect of Mysore geology. His very intimate and intensive knowledge of the Archæan rocks, both in and outside Mysore, together with his ripe experience and mature judgment in this field of study naturally gave him a prominent place in the foremost ranks of Indian geologists.

As Professor of Geology in the Mysore University for 12 years Mr. Sampat Iyengar was actively associated with the work of the University; and the present leading position which the Geology Section of the University occupies among similar institutions in India and the reputation which it enjoys as a place for instruction and centre of research, is in no small measure due to his untiring endeavours.

Apart from his eminence as a geologist, the late Mr. Sampat Iyengar possessed certain admirable traits of character which largely contributed to make his personality really 'dynamic'. An honest and whole-hearted devotion to duty, a burning enthusiasm for work, a frank and fearless expression of views, a stern sense of discipline and an uncompromising adherence to principles—these were some of Mr. Sampat Iyengar's outstanding virtues for which he will ever be remembered.

In his private life, Mr. Sampat Iyengar was orthodox, simple, and unostentatious. By his genial manners and genuine affection he had formed a large circle of friends to many of whom his death comes with all the poignancy of a personal bereavement.

L. RAMA RAO.

* * *

WE deeply regret to announce the death of Dr. S. K. Mukerjee, M.Sc. (Allahabad), D.Sc. (London), Reader in Botany at the University of Lucknow, Honorary Secretary of the Indian Botanical Society, Fellow of the Linnean Society of London. He died at Lucknow on August 5, 1934, after a brief illness at the age of about 37 years.

## An Alternative Atom.

In a letter addressed to the *Sunday Statesman* (Aug. 5, 1934) Dr. R. Samuel, Dr.Phil. (Göttingen), F.Phys.Soc., Professor of Physics, Muslim University, Aligarh, has critically examined the theory of Dr. Tutin concerning the structure of the atom. Dr. Tutin's attack on the classical Rutherford-Bohr atom, which has received much publicity in the non-scientific press, according to the Professor, is "ill-founded and far from the truth." "In order to construct quantised orbits of the order of magnitude of the atoms, he has to assume new electrical forces of non-Coulombian character, which have never been observed and for whose existence there is no evidence whatever. In order to explain Rutherford's experiments on the scattering of X-particles, he has to ignore these forces later on but in spite of this he is not able to come to an agreement between his theory and experimental results. Since in his theory the mass of the atom is not concentrated in the nucleus but assumed to form mainly the outer sphere of the atom, the theory falls into terrible and ridiculous difficulties, the moment he deals with isotopes. These few arguments may be sufficient to show that 'all his results are just pious hopes and no more, and most of them are demonstrably wrong'."

## Letters to the Editor.

### Priority in Lac Research.

USUALLY lac insects have two life cycles but O'Conor[1] mentions localities supposed to yield three crops of lac per year. Imms[2] and Chatterjee confess inability to refer to their source of information in their publication but mention having tried to discover a trivoltine insect. In a paper published in 1919, I[3] made myself responsible for such a positive finding with regard to Mysore. The late Mr. Howlett, when he visited Bangalore as a Member of the Lac Enquiry Committee, expressed hesitation in believing this fact and I offered to convince him by sending brood lac at a time when only a trivoltine species could yield larval swarming. In their joint Report issued after Howlett's demise, his colleagues Lindsay[4] and Harlow write: "The fact that we are still unable to say whether there is a trivoltine variety....is an indication of the extent to which its general study has been neglected......Whether this is the case or not remains to be seen but it is interesting to note that from *Shorea talura* in Bangalore which originated from a swarm in the latter part of December (larvæ) swarmed on 21st April 1921, a remarkably early date. This seems to be the most definite evidence as yet available ...." The brood lac referred to was sent by me and I had hoped to read a confirmation of my discovery in the interests of the lac industry or a mention of my name. On the contrary the report devotes two pages criticising some of my theories which have since been substantiated by the findings of Sreenivasaya and myself. I had reasons to protest against an attitude where the report was loud in declamation and silent in recognition, both to my disadvantage. I consulted the then Director of the Indian Institute of Science who gave me to understand that it is immaterial for Science, who says it; the publicity of a discovery after all is the main objective of every worker. This altruistic principle, however, loses its hold on the mind as memory gathers further sad experience.

When Howlett came to Bangalore he received a typescript report of another work containing about 25 photographic illustrations on which Fowler[5] writes, "Mr. Mahdihassan has spent some months in the Department studying the anatomy and physiology of the lac insect. With the aid of the Minot Microtome he has made a number of interesting sections and claims to have succeeded in identifying the special glands concerned with the production of the various substances found in stick lac, *viz.*, wax, hard and soft resins, etc. The work has been submitted to the Officers of the Government of India conducting a special enquiry into the subject of lac." In the Report on Lac by Lindsay[4] and Harlow no mention is made, however, of this fact. On the contrary the *Ann. Rep. for 1919-20 of the Board of Scientific Advice for India* (Pub. 1921), contains the following statement from Beeson: "A microscopic examination of the internal morphology of lac insects has been carried out under the direction of Mr. F. M. Howlett with the object of discriminating specific differences in the form of lac insect from different kinds of host tree." If this had been the object of research, it was more likely that the external morphology of insects from different trees would first be studied. At any rate, similar problems, for example, distinguishing different species of phylloxera forming galls on the grape vine, have never been attacked in the complicated way suggested above. I addressed an enquiry to Dr. Beeson at Dehra Dun who kindly referred me to Mr. Fletcher at Pusa who was equally unaware of the work done under Mr. Howlett's direction. In the light of my experience a subtle difference had to be made between Howlett's work, which no doubt his successors at Dehra Dun or at Pusa could have easily traced out, and work done elsewhere, supposed to have been carried out under his direction but completed and its typescript report handed even before the suggestion was ever offered. At the same time when Howlett received my work, copies were also sent to the following:— Prof. Tschirch of Bern, Switzerland, the authority on Resins who had the kindness of mentioning in more than one of his

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My histological paper entitled "Seats of the Origin of Lac Products" recognised stick lac as a concrete where besides lac, several kinds of wax form an inner structure. I had attempted to show the glands responsible for the secretion of each of these products. In a later publication[6] several indications have been made to previous histological findings, *viz.*, "Throughout the undersurface of the skin there are dermal glands. They have long chitinous ducts and with these they look like toy balloons." Prof. Misra[7] in criticising all previous workers generally and Chamberlin particularly says that they "do not mention the presence of any glandular structure associated with these pores". In his historical introduction he entirely ignores the histological findings casually mentioned in my paper of 1923 which he, however, critically refers to in another connection in the same paper. Misra claims "the lac glands are being described and figured here for the first time". I assert that Misra was not the first to have seen these glands; at any rate, he has not given a more exhaustive description than that contained in the very short passage quoted above from me. His illustration of ducts shows them to be wavy and the glandular structures, therefore, resemble spermatozoa. The ducts are of hard chitin and hence they possess a rigidity similar to a wire. I am not interested here in criticising his results but in pointing out that he has ignored my previous findings. In my publication, I have repeatedly emphasised the presence of hard and soft waxes in stick lac.

A histologist would have found wax glands instead of "special lac glands" as named by Misra which is misleading, as it only lends to the assumption that stick lac is a homogeneous substance. Misra's publication is a result of academic work and it is surprising that there should have been other glaring omissions in acknowledging previous work. It may be particularly pointed out that Fig. 1 (B) and Fig. 3 both on Pl. 1 of Prof. Misra's[7] paper, are similar to those already published by Rai Bahadur Misra[8] and by Chamberlin[9] respectively.

It is hoped that in future such plagiarisms will be avoided; that unhealthy rivalry and duplication will be discouraged; and that scientific workers will develop a spirit of genuine research with a sense of responsibility.

S. MAHDIHASSAN.

Hyderabad,
Deccan,
*July 24, 1934.*

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6 Mahdihassan, *J. Sci. Assoc., Vizianagaram*, 1923, **1**, No. 2, 86.

7 Misra, *Proc. Zool. Soc., London,* 1931.

8 Rai Bahadur Misra, *Pusa Bull.*, 1923, No. **142**, 10, Fig. 2.

9 Chamberlin, *Bull. Ent. Res.*, 1923, **14**, Pt. 2, Pl. X, Fig. D.

### Influence of Moon on Earthquakes.

IT is well known that the shape and position of the continents with their high mountains and seas, owe their origin to the great upheavals that have taken place millions of years ago and that are still going on in a moderate scale within the crust of the earth. Some think that the forces which have caused these changes are due to cooling of the earth's crust, while others think that they are due to polar movements caused by the rotation of the earth. Whatever might be the cause, these great upheavals have brought about regions of instability within the crust of the earth, and whenever there is a fresh dislocation due to tectonic movements mentioned above, an earthquake occurs. It is supposed that astronomical bodies, such as Sun and Moon, have no influence in precipitating a quake. It seems, however, that though the astronomical bodies are incapable of precipitating a dislocation, yet they are able to magnify the movement if they can exert their maximum influence during a dislocation.

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### Influence of Moon on Earthquakes.

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If the forces due to Moon and Sun act in the direction in which the dislocation of the crust occurs, then obviously the displacement will be greatly magnified, and would

set a devastating earthquake One is therefore led to suppose that when a quake occurs under such conditions it must spread over a large area and produce great destruction of life and property. It is significant that during the undermentioned Earthquakes *viz.*—

(1) Assam quake (1897) 4-25 p.m., 12th June;
(2) North Bihar quake (1934) 2-25 p.m., 15th January;
(3) Kangra quake (1905) 6 a.m., 4th April;

the positions of the Moon were as follows:—

(1) Moon away from the Sun by about 150° east, *i.e.*, anti-Moon 30° west of Sun.
(2) New Moon.
(3) New Moon.

If we examine Figs. 1 to 3 we see that

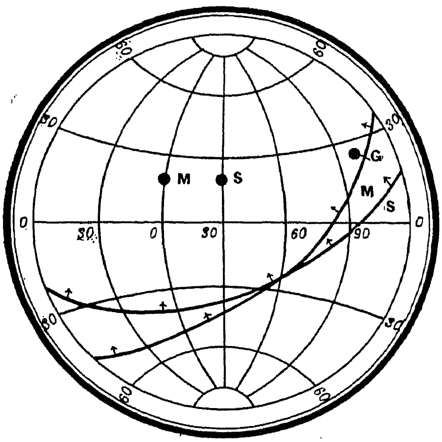


**Fig. 1.**
Assam Quake.
4-25 p.m., 12th June 1897, Near New Moon.

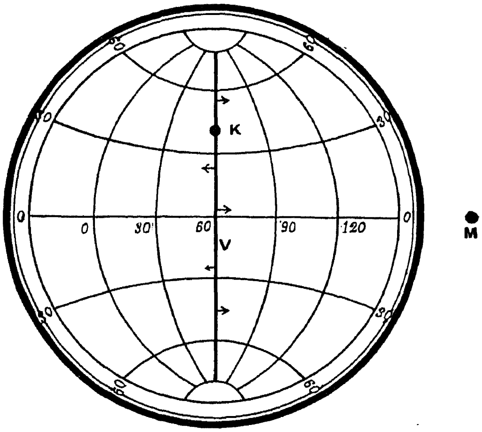


**Fig. 2.**
Kangra Quake.
6 a.m., 4th April 1905, New Moon.

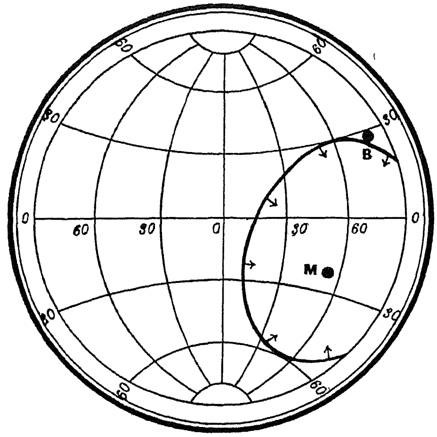


**Fig. 3.**
North Bihar Quake.
2-15 p.m., 15th January 1934, New Moon.

during Assam quake and Kangra quake the vertical tide producing forces influenced the epicentral tract, while in North Bihar quake, the horizontal forces passed through the earthquake area.

Regarding these forces R. D. Oldham wrote long ago:—"With all these objections there remains a sufficiently strong case for the reality of the influence of these forces in determining the time and origin of earthquakes to justify a fuller investigation." It is considered that a fuller investigation of all the devastating quakes might lead to the establishment of a definite law regarding the magnifying influence of the forces due to Moon.

R. N. GHOSH.

152, South Malaka,
Allahabad,
*May 16, 1934.*

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### Fruit and Seed Development in *Tinospora cordifolia* Miers without Fertilisation and Embryo Formation inside.

As the internal morphology of the ovule in the family Menispermaceæ is not much known, during the years 1932 and 1933, the undersigned fixed for investigation a large amount of material of *Tinospora cordifolia* Miers from plants growing in the local botanical garden. This included a large number of fruits in different stages of development, beginning with the carpels of flowers that had just withered and ending with the mature red drupes, and was meant for the study of embryogeny in the species.

We have, however, been surprised to find the total absence of embryos in all this material. The ovules have been found to develop quite normally upto the formation of the embryosac. The megaspore-mother cell gives rise to a complete row of four megaspores. The chalazal one of these develops into an 8-nucleate embryosac of the usual type. The megaspore-mother cell, the linear tetrad of megaspores and the embryosac are deep-seated, the embryosac being covered by about ten layers of parietal tissue. It shows an egg-apparatus of the normal form at the micropylar end, two polar nuclei about the middle, but slightly towards the micropylar end, and three antipodals at the chalazal end. The last resemble those of certain Ranunculaceæ[1] in shifting their position towards one side as the embryosac increases in size during endosperm development. On the contrary, no pollen on the stigmas of the carpels or any pollen-tubes penetrating the nucellus of the ovule have been seen even in more than two hundred ovules examined for the purpose. No fertilisation takes place and the various parts of the embryosac except the two polar nuclei gradually degenerate. The parts of the egg-apparatus lead in the process and then a little later the antipodals share the same fate. The behaviour of the polar nuclei is just the reverse. They fuse with each other in the micropylar half of the embryosac to give rise to a secondary nucleus and the latter without undergoing the process of triple fusion divides to form a large amount of endosperm. The growth of the endosperm on the ventral side of the carpel is very irregular and it consequently becomes ruminate. Along with the development of the endosperm, the embryosac goes on increasing in size and absorbing the nucellus. The integuments of the ovule change into the testa of the seed and the wall of the ovary differentiates into the epicarp, fleshy mesocarp and the stony endocarp of the drupaceous fruit, without any embryo being formed inside.

This absence of embryos in the seeds of apparently normal fruits of *Tinospora cordifolia*, we have also confirmed by dissecting many of them, though it is not possible to put forward any exact cause for the failure of pollination, which appears to be the primary cause for such a development. In the Benares Hindu University Botanical Garden while there are a number of female plants, there is only one male plant at a distance of a few hundred feet from the former. The pollen of this male plant is quite normal; and although no germination experiments have been tried, it appears from its structure to be quite viable. The lack of pollination may be, therefore, due only to the distance between the male and the female plants, the effect of which is enhanced by these plants growing on other trees often with dense foliage, like the mango. But whatever the explanation may be for the lack of pollination, it is quite clear that *in 'Tinospora cordifolia' without the stimulus of fertilisation and without the development of embryo inside, apparently normal seeds and fruits are formed.* In this respect, a comparison can be made with Kashyap's observation in Lahore on the ovules of *Cycas revoluta*.[2] There are only female individuals of this cycad in Lahore, but even then the ovules develop into seeds, which externally look quite normal. Inside only the female gametophyte is developed and there is no fertilisation and embryo formation. As the cause of such a development in *Cycas revoluta*, Kashyap suggested the possible influence of some foreign pollen. In angiosperms, the morphology of the endosperm being different, it is not unlikely that in *Tinospora cordifolia*, the necessary stimulus for the development of the seed and fruit may be coming from the formation of endosperm itself inside and its formation without fertilisation is not an unusual thing even in the Ranales.

A. C. JOSHI.
V. V. RAMAN RAO.

Department of Botany,
Benares Hindu University,
*June 9, 1934.*

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### Kinks on Impact Curves of Struck Strings.

THE present note is meant to indicate that Kaufmann's theory is sufficient to explain the phenomena associated with struck strings, specially with reference to Pianoforte where the striking length $a$ and the elastic strength of the felt hammer are small. In this case particularly Kaufmann's theory when modified for elasticity can be applied with advantage. In order to do this divide the total duration of impact into

[1] Coulter, J. M., *Bot. Gaz.*, 1898, **25**, 73.

[2] Kashyap, S. R., *J. Ind. Bot. Soc.*, 1921, **2**, 116.

two parts: (1) the interval during which the string is not displaced while the hammer felt undergoes compression till at the end of this interval; the second (2) regime begins and the string is displaced from the equilibrium position when Kaufmann's assumption holds good. It may be mentioned that this mode of considering the phenomenon first pointed by the authors in 1930 (*Phil. Mag.*, **9**, 1175, 1930) has also been accepted by Messrs. Ghosh and Kar of Calcutta, (*Phil. Mag.*, **17**, 521, 1931). Now Kaufmann's assumption is

$$\dot{Y} = \dot{Y}_0 \frac{x}{a} \qquad \ldots \qquad \ldots \quad (1)$$

initially at the beginning of second regime without any displacement, and at any subsequent instant the displacement is given by

$$Y = Y_0 \frac{x}{a} \qquad \ldots \qquad \ldots \quad (2)$$

where $\dot{Y}_0$ and $Y_0$ are velocity and displacement of the striking point abscissa $x = a$ measured from the nearer end.

A distribution of velocity in the position $a$ given by (1) and without any displacement has been shown by Sir C. V. Raman, N.L., to be due to discontinuous velocity waves (Fig. 1); one set travelling positively, and

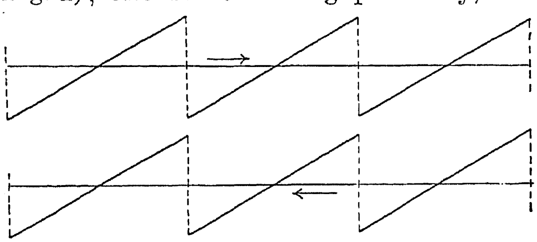

**Fig. 1.**
Discontinuous Velocity Diagram.

the other negatively. These produce displacements similar to that of bowed string, which appear as small kinks (Fig. 2) in the

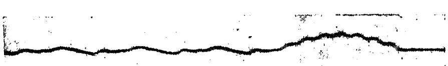

**Fig. 2.**

**Fig. 3.**

time displacement diagrams of any point of the string between the nearer end and the striking point, obtained during the time the hammer is in contact with the string. In fact Kaufmann's theory with slight modifications is sufficient to explain the presence of these kinks in the shorter portion, their absence at the striking point and on the longer side of the string. It is also adequate to explain the appearance of large kinks when $a$ is increased and the length of the other portion is decreased. Fig. 3 shows a large kink, $a = 30 \cdot 7$ cms.; $\beta =$ the point of observation 106 cms.; $\frac{T}{\phi} = \frac{\text{Period of vibration of the string}}{\text{Duration of contact}} = \cdot 7$; while Fig. 4 shows the same drawn theoretically. Details will appear elsewhere.

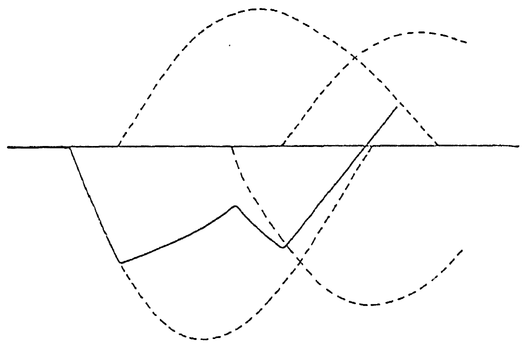

**Fig. 4.**

R. N. GHOSH.
HAJI GULAM MOHAMED.

Physics Department,
Allahabad University,
Allahabad,
*June 21, 1934.*

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### Molecular Weight of Lignin.

THE highest yield of formaldehyde recorded by Freudenberg and co-workers[1] from pinewood lignin is 1·2 per cent. Depending mainly on this result they advanced a structural formula for lignin[2] corresponding to a molecular weight of 2140 (in unpolymerised form). But as the molecular weights of various lignin derivatives lie between 800 and 1000,[3] it is difficult to reconcile Freudenberg's figure with these. The di-oxymethylene group has been found to be very unstable towards acids and by treating jute with 42 per cent. HCl at 20° for 24 hours a lignin has been obtained with a pale rose colour which after repeated washings with

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[1] *Ber.*, 1933, **66**, 262.
[2] *Cellulose Chemie.*, 1931, **12**, 269.
[3] Fuchs, *Chemie des Lignins*, 1926, 178.

dilute NaOH, gives 2·78 per cent. of formaldehyde (estimated by the Dimedone method).

Unlike aliphatic compounds, aromatic bodies with $O\text{-}CH_2\text{-}O$ groups do not give formaldehyde quantitatively by acid hydrolysis—the phenolic groups combine with the HCHO liberated to give resins; the temperature and concentration of acid employed for the estimation of HCHO being the same as those suitable for resin formation.[4] In the case of piperonylic acid 77·6 per cent. HCHO was obtained—also when HCHO and excess of protocatechuic acid were distilled with 28 per cent. $H_2SO_4$ very nearly the same percentage was obtainable.

Assuming as Freudenberg does, that only one $O\text{-}CH_2\text{-}O$ group is present in lignin and also that 2·78 per cent. HCHO represents 77·6 per cent. of theory, the molecular weight comes to 830. Rassow and Wagner[5] determined the molecular weight of glycol-lignin by Barger-Rast method and gave the figure as 840. Freudenberg's formula therefore needs modification.

PULIN BEHARI SARKAR.

Chemical Laboratory,
Dacca University,
*July 15, 1934.*

### Equisetum in Gujerat.

THE occurrence of *Equisetum* at Poona is perhaps the only record of its existence in the Presidency of Bombay.

The writer came across a dwarf (about six inches) but fertile specimen of *Equisetum* in October 1931 at Malsar in the Baroda State. The plant was isolated in a cleft formed by hardened clay in the bed of the river Narbada. It was supposed to be an accidental exotic in a district where ferns are rare or none.

This year at the end of May, I happened to visit a place called Balaram fifteen miles N.-E. of Palanpur. It is one of the outlying hills of the Aravalli range on the river Banas. Here, I found the shady slope of the hill covered all over by *Equisetum.* The fine green plants about twenty-four inches in height on hard limy soil apparently enjoyed the hot weather (115° temp.). They had stout dark rhizomes and a few branches but no cones.

This find of *Equisetum* at two different places about hundred miles apart in Gujerat and that too, one from a place supposed to be arid and sandy is worth noting.

S. C. DIXIT.

Wilson College,
Bombay,
*July 1934.*

### Fluorescence in Wood under Ultra-Violet Light.

WHILE we were engaged on the study of the fluorescence in wood, under ultra-violet light, a short paper by Dalton on 'Woods that shine in the dark', appeared in the *Canadian Woodworker and Furniture Manufacturer*, 1934, p. 9. In this note certain observations have been made which are not in accordance with our findings and we, therefore, take this opportunity to record the results of our preliminary examination, a detailed account of which will appear elsewhere. Dalton remarks that "with the new Argon ultra-violet glow lamps and suitable light suppressing filters a large number of wood specimens were found to possess very definite fluorescent features. In practically all instances, the fluorescence was of a yellowish green colour."

We have examined over a hundred specimens in wood blocks, and in powder form, as well as their extracts in some common organic solvents, under a 'Hanovia' Quartz Mercury Vapour Lamp fitted with Wood's filter. We find that most of the woods fluoresce, the colour of the fluorescence in the block form and in the powder form being practically identical but, in many cases, different from the colour of the fluorescence of their extracts. Furthermore, the colour of the fluorescence in different woods is different, ranging from snuff brown to violet with practically all shades of orange, yellow, green, blue and indigo, between these extremes. The intensity of the fluorescence, however, is not restricted to any particular part of the wood. In some cases, the heartwood fluoresces more brilliantly than the sapwood, and in others the reverse is the case. Then again, in many cases, the colour of the fluorescence in sapwood and heartwood is very different.

In making extracts of the wood powders (100-mesh) we have employed absolute alcohol, acetic acid, ethyl ether, chloroform and xylene. Of these, alcohol and acetic acid extracts showed fluorescence in almost

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4 Bary and others, *Natural and Synthetic Resins*, 118.

5 *Wochenblatt f. fabrikation*, 1932, **63**, 103.

all those cases where the original wood fluoresces, while in the case of ether, chloroform and xylene extracts, only in a few cases was the fluorescence observed and that too very faintly. Results for some typical cases are recorded below :

| Species | | Wood Blocks | | Powder | | Extracts | |
|---|---|---|---|---|---|---|---|
| | | Colour in Sunlight | Colour in Ultra-violet light | Colour in Sunlight | Colour in Ultra-violet light | Alcoholic in Ultra-violet light | Acetic in Ultra-violet light |
| *Acacia arabica* | S | YO (B.T.M.) | BV (B.T.L.) | $OY_{T_2}$ | BV (B.T.L.) | $VB_{T_2}$ | $VB_{T_2}$ |
| | H | O (B.T.D.) | OY | VO (B.T.L.) | OY | YG | YG |
| *Acacia catechu* | S | $OY_{T_2}$ | Y | $Y_{T_2}$ | $OY_{S_1}$ | BV (B.T.L.) | B (B.T.L.) |
| | H | O (B.T.D.) | OR (B.T.D.) | YO (B.T.L.) | R (B.T.D.) | YO (B.T.L.) | $Y_{S_1}$ |
| *Adina cordifolia* | S | $Y_{T_2}$ | $Y_{T_1}$ | $Y_{T_1}$ | Y | $V_{S_2}$ | $G_{S_1}$ |
| | H | | | | | | |
| *Albizzia lebbek, A. procera & A. stipulata.* | S | WGr | B (B.T.L.) | WGr | B (B.T.L.) | $BV_{T_1}$ | GY |
| | H | YO (B.T.D.) | OY | YO (B.T.M.) | YO | $Y_{S_1}$ | $GY_{T_1}$ |
| *Cassia fistula* | S | YO (B.T.L.) | $YO_{S_2}$ | YO (B.T.L.) | Y (B.T.L.) | $GY_{T_1}$ | $Y_{S_1}$ |
| | H | OR (B.T.L.) | RV | $YO_{T_2}$ | RV | $RV_{T_2}$ | BV |
| *Cedrela toona* | S | YO (B.T.L.) | Y (B.T.D.) | YO (B.T.L.) | Y (B.T.D.) | $G_{T_1}$ | V (B.T.M.) |
| | H | O (B.T.D.) | O (B.T.D.) | O (B.T.D.) | O (B.T.D.) | $OY_{S_1}$ | $OY_{T_2}$ |
| *Morus alba* | S | WGr | $V_{T_1}$ | WGr | $RV_{T_1}$ | $V_{T_1}$ | $VB_{T_1}$ |
| | H | Y (B.T.L.) | $V_{T_1}$ | $OY_{S_1}$ | $YO_{S_1}$ | $BV_{T_1}$ | BV |

*Colour standard* issued along with Mullekin's "*Identification of the Commercial Dye-stuff*," John Wiley & Sons, New York.

| | | | |
|---|---|---|---|
| VR—Violet-red | GY—Green-yellow | V—Violet | B.T. Broken Tones |
| OR—Orange-red | YG—Yellow-green | RV—Red-violet | L. Light |
| RO—Red-orange | BG—Blue-green | WGr—Whitish-grey | M. Medium |
| YO—Yellow-orange | VB—Violet-blue | $S_1$—$Shade_1$ | D. Dark |
| OY—Orange-yellow | BV—Blue-violet | $T_1$—$Tone_1$ | S Sapwood |
| | | | H Heartwood |

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Dehra Dun, U.P.,
*July 24, 1934.*

S. KRISHNA.
K. A. CHOWDHURY.

## Crystal Structure of the Fluoberyllates.

RECENTLY N. N. Ray[1] has observed from solubilities, molecular volumes and formation of mixed crystals that the simple and complex fluoberyllates of metals are completely isomorphous with the corresponding sulphates. Goniometric and X-ray studies of these isomorphous crystals were accordingly undertaken for a thorough investigation.

From goniometric measurements, the fluoberyllates of potassium, rubidium, ammonium and thallium were found to belong to the orthorhombic bi-pyramidal class ($V^h$) to which the sulphates of these metals are also known to belong. The crystallographic axial ratios of these fluoberyllates, and those of the corresponding sulphates are given in Table I.

TABLE I.

| Metallic radical | Fluoberyllates | | | Sulphates | | |
|---|---|---|---|---|---|---|
| | *a* | *b* | *c* | *a* | *b* | *c* |
| Potassium | 0·5744 | 1 | 0·7431 | 0·5727 | 1 | 0·7418 |
| Rubidium | 0·5766 | 1 | 0·7560 | 0·5723 | 1 | 0·7485 |
| Ammonium | 0·5665 | 1 | 0·7241 | 0·5635 | 1 | 0·7319 |
| Thallium | 0·5638 | 1 | 0·7368 | 0·5555 | 1 | 0·7328 |

[1] *Zeit. Anorg. U. Allg. Chem.*, 1931, **201**, 289.

The space group of potassium fluoberyllate was very carefully determined by oscillation photographs of ranges 10° in a camera of high resolution (the diameter being 17·2 cm.) and was found to be $D_{2h}$ $p\mu\gamma\nu$ (*i.e.* $V^{16}_h$ according to Schonflies notation). This is also the result of the most reliable determinations,[2] of the space group of potassium sulphate.

Rotation photographs of the crystals of rubidium, ammonium and thallium salts also show the same space-group. This independent determination also agrees with a very recent publication of the space group of ammonium fluoberyllate by Hultgren.[3] The axial lengths in Angstrom units of these crystals as measured from layer line photographs are given in Table II.

Determination of the positions of the atoms by measurements of intensities of X-ray reflections is in progress.

TABLE II.

| Metallic radical | Fluoberyllates | | | Sulphates | | |
|---|---|---|---|---|---|---|
| | *a* | *b* | *c* | *a* | *b* | *c* |
| Potassium | 5·63 | 9·83 | 7·29 | 5·73 | 10·00 | 7·42 |
| Rubidium | 5·85 | 10·13 | 7·66 | 5·94 | 10·39 | 7·78 |
| Ammonium | 5·89 | 10·39 | 7·49 | 5·95 | 10·56 | 7·72 |
| Thallium | 5·87 | 10·43 | 7·68 | .. | .. | .. |

N. N. Ray[4] also investigated the double fluoberyllates as well as several double salts of fluoberyllates with sulphates and he found all of these to be physically and chemically similar to the corresponding double sulphates. Goniometric studies revealed a crystallographic isomorphism between these two series also and showed that all these fluoberyllates belong to the class Monoclinic, Prismatic ($C^h_2$) with the following axial ratios and axial angles ($\beta$).

TABLE III.

| Metallic radical | Double fluoberyllate $(BeF_4)_2$ | | | | Double sulphate $(SO_4)_2$ | | | |
|---|---|---|---|---|---|---|---|---|
| | *a* | *b* | *c* | $\beta$ | *a* | *b* | *c* | $\beta$ |
| $Am_2Zn$ .. .. | 0·7387 | 1 | 0·4909 | 106° 34′ | 0·7368 | 1 | 0·4997 | 106° 52′ |
| $Am_2Co$ .. .. | 0·7405 | 1 | 0·4852 | 106° 46′ | 0·7392 | 1 | 0·4985 | 106° 56′ |
| $Am_2Ni$ .. .. | 0·7373 | 1 | 0·4914 | 106° 40′ | 0·7370 | 1 | 0·5032 | 107° 4′ |

| Metallic radical | Sulphato fluoberyllate $(SO_4BeF_4)$ | | | | Double sulphate $(SO_4)_2$ | | | |
|---|---|---|---|---|---|---|---|---|
| | *a* | *b* | *c* | $\beta$ | *a* | *b* | *c* | $\beta$ |
| $Am_2Zn$ .. .. | 0·7382 | 1 | 0·4942 | 106° 43′ | 0·7368 | 1 | 0·4997 | 106° 52′ |
| $K_2Ni$ .. .. | 0·7405 | 1 | 0·5077 | 104° 44′ | 0·7379 | 1 | 0·5020 | 105° 0′ |

It is also intended to make a complete X-ray study of this interesting series of double salts.

P. L. MUKHERJEE.

Physics Laboratory,
Dacca University,
Ramna,
*July 1934.*

[2] Hermann and Ehrenberg, *Zeit. f. krist.*, 1929, **70,** 163.

[3] *Zeit. f. krist.*, 1934, **88,** Part III.

[4] *Zeit. Anorg. U. Allg. Chem.*, 1932, **206,** 209.

## Antirachitic Factor in Kabuli Chhola Oil.

IN two of our previous communications, published in *Current Science*,[1] we referred to some important points regarding the presence of oil-soluble vitamin A in some pulses and fishes. A few physiological and spectrographic records were also published. In the present communication we reproduce two X-ray photographs.

Fig. 1 is that of a rat kept on rachitogenetic diet all through.

Fig. 2 was fed on rachitogenetic diet from the 7th February 1934 to the 5th March 1934.

From the 5th March, the rat No. 2 was given a daily dose of freshly prepared Kabuli Chhola Oil.

On the 17th March, under X-ray observation, a distinct indication in calcification was noted in rat No. 2.

X-ray photographs here reproduced were taken on the 5th April 1934.

There was a litter of eight rats born on the 5th January 1934. These eight rats formed the subject of the present investigation. All of them gave similar results under experimental conditions.

**Fig. 1.** Rachitic.

**Fig. 2.** X-ray Photograph after Kabuli Chhola Oil Feeding.

It may be mentioned that weight of bones, bone ash, calcium and phosphorus present in the ashes were also determined. The results all went to confirm the anti-rachitic quality of Kabuli Chhola Oil.

Bones of non-rachitic rats weighed considerably heavier than rachitic ones. Again the percentage of ash of *bones dried at 100°C.* was found to be as follows :—

Bone ash of non-rachitic rats 53·13.

Bone ash of fully rachitic rats 44·68.

Bone ash of partially cured rats 47·78.

Finally the Ca to P ratio were in the following order :—

Non-rachitic, 2·20 ; fully rachitic, 1·91 ; and Rickets cured (Rachitis cured), 2·06.

Other details as regards calorific value and comparative results obtained with different pulses will be published in the *Transactions of the Bose Research Institute*.

N. C. NAG.
H. N. BANERJEE.

Bose Institute, Calcutta,
*July 30, 1934.*

[1] Nag and Banerjee, *Curr. Sci.*, 1933, **2**, 3, 95.
Banerjee and Nag, *Curr. Sci.*, 1933, **2**, 4, 131—132.

## A Conductometric Method for Moisture in Bagasse.

WHEN a definite quantity of moist bagasse is digested hot with a common salt solution of known electrical conductivity the distribution of the salt through the water in the bagasse results in a depression in the conductivity of the original solution and this depression will be a measure of the amount of moisture in the bagasse sample. It is essential to make an allowance for the conductance of the 'residual juice' and this should only be of lower magnitude compared to the conductance of the salt solution when accurate quantitative results are desired. The sugar chemist is already familiar with the digestion with plain water for determining the sucrose per cent. bagasse and it is only a small modification to use a salt solution instead and derive both the sucrose and moisture data in one experiment. The great advantage of this method is the elimination of the drying method which requires several weighings and separate samples for moisture and sucrose determinations. By employing the familiar Deerr digestion an unprepared and a large sample can be analysed. The simultaneous determination of both sucrose and moisture on one and the same sample results in a better derivation of the fibre figures especially where fibre per cent. cane is calculated indirectly. These advantages of the conductometric method more than set off the high cost of conductivity equipment the necessity of which is already being felt for making such determinations. One limitation of this method, however, is its applicability only for the final bagasse and when the common method of plain water inhibition is practised at the mills.

Experiments employing approximately normal solution of sodium chloride and about 500 gms. of bagasse in a Deerr digestion have given results which are in agreement within 1½% with those obtained by drying to constant weight. The moisture content of the samples analysed lay between 40% and 50%. Some samples were deliberately dried partially and then analysed. The results were again satisfactory. All these analyses were done on preserved samples and their extracts were of as low a pH as 4·6 but nevertheless the method works and it should succeed under the better conditions prevailing during the routine factory analyses.

The conductance of the residual juice enters into the calculation only as a correction factor provided the brine solution is strong enough (at least uninormal) and an average value for this factor can be experimentally established once for all and applied always it being necessary to redetermine it only very occasionally. A better method is to correlate the conductance or even the brix of the 'last-expressed juice' with the 'residual juice' correction. Such a correlation between the composition of the 'last-expressed juice' and the 'residual juice' is already in practice while calculating the fibre per cent. bagasse.

A detailed paper on this new method of bagasse analysis will appear elsewhere.

G. GUNDU RAO.

Indian Institute of Science,
Bangalore,
*August 7, 1934.*

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## The Inactivating Effect of Ultraviolet Light on the Virus of Rabies.

CLIFTON (1931),[1] Perdrau and Todd (1933)[2] found that methylene blue had the photodynamic property of inactivating certain viruses: *e.g.*, Bacteriophage, Herpes, etc. Shortt and Brooks (1934)[3] found that this dye exercised a similar action on the Fixed Virus of Rabies in the presence of Sunlight. Galloway (1934),[4] almost simultaneously, made a similar observation, but was not able to confirm that of Shortt and Brooks' when using unfiltered suspensions of infective material. Since Shortt and Brooks used sunlight while the other observers used an electric filament or Pointolite lamp, it occurred to us that the success recorded by Shortt and Brooks was, perhaps, due to the action of ultraviolet rays of light. Accordingly, we repeated their experiments using a quartz mercury vapour lamp as the source of ultraviolet rays. We found that by this means we were able to inactivate a 0·5 per cent. centrifuged emulsion of Rabies-infected rabbit's brain (Fixed Virus)

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[1] Clifton, C. E., *Proc. Soc. Exp. Biol. N. Y.*, 1931, **28**, 745.

[2] Perdrau and Todd, *Proc. Roy. Soc.*, 1933, **B 112**, 277 & 288.

[3] Shortt and Brooks, *Ind. Jour. Med. Res.*, 1934, **21**, 581.

[4] Galloway, I. A., *Brit. Jour. Exp. Path.*, 1934, **15**, 2, 97.

in as short a time as 60 seconds exposure to the ultraviolet rays of light. With shorter exposures, 15 and 30 seconds, the Virus appeared to be attenuated but not completely inactivated, since some animals inoculated with the brain emulsion irradiated for the shorter periods developed Rabies while the others did not; in the former the incubation period was somewhat prolonged. It was found, further, that inactivation was as complete in the absence of methylene blue as in its presence (dilution of 1 in 25,000). Irradiation with the quartz mercury vapour lamp had a similar effect on Street Virus Rabies. It then occurred to us that this method of inactivation of the Virus might be used instead of the carbolic acid method for the preparation of Rabies Vaccine; the advantage being that 30 days are required for its preparation by the latter method, while by the former a few days would suffice. The present-day Rabies Vaccine is a 5 per cent. emulsion of infected brains in normal saline solution. Accordingly, we irradiated a 5 per cent. emulsion of the brain of a rabbit that was infected with the Fixed Virus Rabies (Paris) for 15 minutes. The emulsion was inoculated subdurally into rabbits almost immediately afterwards. Two out of the three animals so inoculated subdurally died showing typical signs of Rabies. This we thought was due to the ultraviolet rays not having penetrated deep enough into the infected opaque emulsion. We, therefore, oscillated the shallow dish containing the emulsion while it was being irradiated for 20 minutes; by this means the ultraviolet light was enabled to reach the whole of the emulsion. The emulsion, so oscillated and irradiated, was found to be inactive on subdural inoculation into rabbits. These inoculations were carried out on the 6th of July and at the time of writing, one month later, the inoculated animals are alive and well.

Details of this work together with those of experiments designed to determine the antigenic property of ultraviolet irradiated Rabies Vaccine will be reported in the *Indian Journal of Medical Research* at a later date.

G. SANKARAN.
W. A. BEER.

Pasteur Institute,
Coonoor,
*August 10, 1934.*

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### Enteropneusta from Krusadai Island.

THE occurrence of Enteropneusta in the neighbourhood of Krusadai, South India, was first made known by F. H. Gravely and recently the members of the staff of the Zoology Department, Central College, have obtained a very large collection of these interesting forms. S. G. M. Ramanujam has also taken specimens from the same area but it is rather surprising that our collections do not include any of the specimens represented in Dr. Ramanujam's, which does not possess a single form contained in our material. But still both parties were investigating the same area and this rather curious phenomenon of distribution is worth carefully looking into.

I have examined the specimens contained in the two collections. Dr. Ramanujam's specimens are *Ptychodera minuta* and *Glandiceps hacksi* which have been reported from Madras coast by K. Ramunni Menon. The occurrence of these forms near Krusadai must be an interesting fact in their distribution. Among the specimens contained in our collection, there are two distinct species of the genus *Chlamydothorax*. It may be recalled that Spengel mentions in his monograph on Enteropneusta *Ptychodera ceylonica*, two specimens of which were obtained from the west coast of Ceylon. They were comparatively small and on an examination of the external morphology of the branchiogenital and liver regions, but without examining the internal anatomy he concluded that the Ceylon specimens were identical with *Pt. bahamensis:* the latter according to Spengel's suggested scheme of classification would rightly be regarded as *Ch. bahamensis*.

I have carefully examined the internal anatomy of the Krusadai forms and I have no hesitation in saying that there are two different species of *Chlamydothorax* contained in our collection. Spengel's specimens of *Chlamydothorax ceylonica* are not procurable from the University Museum of Giessen, or Berlin and none from Colombo Museum. It is unfortunate that Spengel did not leave on record a description of the internal anatomy of the Ceylonese Enteropneusta; the situation becomes further complicated if we add another Enteropneusta also insufficiently described, *viz.*, *Pt. tricollaris* (Schmarda) from Ceylon.

In examining my material, I have kept these two undescribed or partly described

forms before my mind and I have come to the conclusion that Spengel's *Ch. ceylonica* is entirely different from *Ch. bahamensis*: and Schmarda's *Pt. tricollaris* is the adult specimen of *Ch. ceylonica*. In the paper which I am preparing for publication, I retain *Ch. ceylonica* as a distinct species in which case *Pt. tricollaris* should be treated as its synonym. The second species represented in our collection will be described as *Ch. krusadiensis*. I have assigned one of these forms to Spengel's species, *Ch. ceylonica*, purely on the presumptive basis that this might have been Spengel and Schmarda's forms, and yet it might happen that this species was not known to these authors.

Central College, Bangalore, *August 8, 1934*. C. R. NARAYAN RAO.

### *Balaenoptera indica*, Blyth.

MR. MCCANN'S note on the great Indian fin-whale published in *Current Science*[1] is interesting and obviously the writer is of opinion that this large whale deserves the rank of a separate species assigned to it by Blyth. Blanford[2] is not quite sure about the position of the great Indian whale, for he observes that "as already pointed out, this species is probably the same as the great northern fin-whale (*B. sibbaldi*). Beddard[3] writing on the distribution of Balænoptera points out that there seem to be no substantial grounds for retaining such species as *B. indica, B. patachonica, B. schlegelii*, etc." Blyth[4] relies on the comparative slenderness of the mandible of the Indian forms of the great fin-whale for elevating them to the rank of a distinct species: a specimen said to be 84 feet long, had a lower jaw measuring only 21 feet. Collett[5] has mentioned that specimens of *B. sibbaldi*, measuring 80–90 feet long, have lower jaw bones two-ninths of the total length and for a specimen 90 feet long Collett gives 20 feet as the length of the mandibles. Mr. McCann's measurement of the mandible of the specimen recently stranded in Bombay is in accordance with the above figures. In the absence of definite knowledge of the other external and internal characteristics of the Indian forms, it is risky to maintain that they constitute distinct members separable from *B. sibbaldi*. The occurrence of these whales in the tropical seas during summer which, according to the migration theory, should be found in the colder latitudes at the time, is no doubt a strong point, but will not constitute a character for creating a separate species.

Central College, Bangalore, *August 8, 1934*. B. R. SESHACHAR.

1 *Curr. Sci.*, 1934, **3**, 1.

2 *Fauna of British India—Mammalia, 1881–91*, 568.

3 *A Book of Whales*, 159.

4 *Journ. As. Soc. Bengal*, 1859, **28**, 488.

5 *Proc. Zool. Soc.*, 1886, 253 and *Fauna Brit. Ind. Mamm., 1888-91*, 567.

## The Silk Industry of Japan.

By N. Rama Rao,

*Rtd. Director of Industries and Commerce in Mysore.*

MR. C. C. GHOSH'S monograph on the Silk Industry of Japan (Scientific Monograph No. 8 of the Imperial Council of Agricultural Research) is what a publication of this kind should be—a study by a competent sericulturist of the Silk Industry of the premier sericultural country of the world. Such a study is sure to have been conducted with insight, and with a mind keenly alert to educative value. The publication comes with dramatic fitness at a time when the Tariff Board enquiry has drawn attention to the importance of the Indian Silk Industry; and the grant of protection, albeit inadequate, for Indian Silk by the Government of India has imposed on Silk-producing Provinces and States the duty of developing their sericulture in fulfilment of their implied promise to the Indian weaver and the Indian consumer.

The organisation in Japan has evolved as the result of a purposeful policy working towards a clearly conceived objective. Japanese sericulture is an important expression of Japanese patriotism, and nothing is more striking than the way in which the whole country, from the farmer to the Imperial family, has worked together for the

improvement of Japan's most important industry.

In the silk-producing parts of India natural conditions are quite as favourable as in Japan to the growth of the industry. The present reviewer, speaking with intimate knowledge of Mysore, can say without fear of informed contradiction, that this State enjoys exceptional advantages in climate and economic environment, and offers a practically unlimited scope for the expansion of sericulture. This was the opinion also of Italian and Japanese experts who visited Mysore, and went over the silk-producing tracts, with an eye to business. In Mysore, the industry is essentially connected with welfare. To quote the memorandum submitted to the Tariff Board:

"The industry is of great economic importance to the State. In some form or other it provides employment to about two lakhs of families.... nearly a sixth of the total population. In the rural economy sericuture plays a very important part.... enabling the family to turn its waste time to account and earn a return which in many cases makes all the difference between a half-starved and hopeless life, and a self-respecting competence."

This can probably be said with equal truth of other parts of India. The Governments of silk-producing states and provinces could not do better than follow in the footsteps of Japan in regard to their Sericulture.

The most striking features of the Japanese organisation are its comprehensiveness of scope, and the manner in which the assistance of the State reaches out into its most minute ramifications providing here a framework, there a suggestion test or scrutiny, elsewhere a gesture or more substantial token of approval or recognition. This immanence, so to speak, of watchful solicitude is calculated to inspire the worker with confidence, and make him respond nobly. From the cultivation of mulberry onwards every process is being constantly watched, tested, improved and standardised with unflagging vigilance. The Government not only desires the maximum of industrial efficiency; it is most anxious to maintain the reputation of Japanese silk for quality in the world's markets. There is no doubt that the success of Japanese sericulture is due to sustained scientific research, the results of which are promptly transformed into industrial practice by an admirable organisation which reaches the farmers, and to a careful study of markets made with a desire to supply them with acceptable goods. As Mr. Ghosh says:—

"The secret of Japan's success in foreign markets is (a) close and continued study of the requirements of these markets by special representatives, and (b) standardisation."

Of course, standardisation means careful supervision and scrutiny and a rigid enforcement of standards by conditioning house tests and what is even more effectual, by the enlightened public opinion within the industry itself.

In Japan, standardisation is possible in the aggregate, because it is possible in every section of the industry. There is a distinct organisation for each part, which is so developed as to afford scope for specialisation in that part. It is difficult to conceive of an arrangement more conducive to rapid practical progress. For instance, the preparation of mulberry grafts—for in Japan there is no promiscuous propagation from seeds and cuttings—is a specialised industry giving employment to about 200,000 workers. The admirably organised and controlled system of egg-manufacture supplies the huge requirements of the industry with disease-free hybrid eggs, carefully selected and crossed according to the needs of each locality. This system furnishes employment to 8,000 establishments of scientific workers.

The rearing is done under the supervision and guidance of experts engaged on a co-operative basis for the season, and this has called into being a class of people who have to develop practical usefulness to earn a living. Then there are organisations for stifling cocoons, selling them, and so on and so forth, till the cocoons get to the reeling establishments, small and great, ranging from a girl with a *charka* to filatures with thousands of basins and workers "In 1927, the reeling factories 83,568 in number employed 462,591 women and 33,335 men." In Japan it took 30 years to revolutionise reeling and raise it from a state not very unlike ours to its present world-renowned quality. About 90% of Japan's silk is now reeled in filatures.

Though the bulk of Japan's raw silk is exported, there is enough left to support a flourishing weaving industry. Japan has a considerable export in silk goods, thanks to the excellent organisation of weaving with the help of domestic looms and cheap electric power.

The monograph is so interesting and so packed with facts, that to quote is a temptation fraught with danger; but no apology is perhaps necessary for two short extracts on two matters of supreme importance to Indian sericulture—especially Mysore and Kollegal sericulture—namely, seed production and sale of cocoons. It is obvious that a defect in either will rob the farmer of the fruits of his labour.

In Japan "Rearers of silk-worms are prohibited by law from producing eggs for rearing. The Imperial Sericultural Experimental Station is engaged on testing silk-worms from all over the world, and selecting suitable ones for Japan. It recommended for rearing the $F_1$ crosses of certain races. These races are made available to the Prefectural Experimental Stations which test them for ............local conditions. The parent worms are reared in the Prefectural Experimental Stations and made available to licensed seed-producers for producing $F_1$ cross for the general rearer......There are 8,000 licensed egg-producers, and more than 40,000 persons engaged in the sale of these eggs."

Perhaps the most notable achievement of the Sericultural Department in Mysore has been in this direction. Races of worms from all over the world have been tested, and crosses selected such as would result in an increase of 40% in the return to the rearer. What is even more important is that the rearer, that most conservative member of a conservative race, has been educated to recognise and accept the improvement. But for want of sufficient grants from the Government, the industry has been denied anything like appreciable benefit from this great achievement.

Again in regard to sale of cocoons:

"The recent development is sale through co-operative drying societies. Government is encouraging and subsidising these in order to foster the trade in dried cocoons."

This is a measure well worthy of adoption in all parts of India, except Kashmir where silk is a state monopoly.

The monograph is so economical in words that further condensation would probably result in unintelligibility, and we shall, therefore, commend a study of the text itself to such of our readers as require more information than can be expected in a review. The high message of Japan to India is seriousness and a realisation that the human value of industrial research lies in the speedy incorporation of its results in industrial practice. Else, knowledge comes, but wisdom lingers. The example of Japan should teach us how knowledge and wisdom can march hand to hand to prosperity.

# Research Notes.

## A Cathode Ray Furnace.

THE cathode rays produced in a rarified medium by a high tension current heat up very strongly any body (anti-cathode) placed in their path. This has been used by different experimenters to realise very high temperatures. Crookes (1879) was the first to make use of such an arrangement to melt platinum. In a recent paper in *Bull. Soc. Chem. de France*, Feb. 1934, p. 262, M. F. Trombe has described with details another cathode ray furnace worked by a transformer 110 to 20,000 volts, and utilising a current of 100 m.a. at the high tension. It consists essentially of a quartz bulb of three litres capacity into which are ground the aluminium electrodes—cooled by a current of water—and the support for the anti-cathode. A plane window placed near the tungsten anti-cathode crucible makes it easy to observe and measure optically the temperature realised. The apparatus is characterised by a regularity in functioning, and the temperature reaches to 2700°C. in 15 to 20 seconds.

M. A. G.

## On a New Mass-Spectrograph.

IN the *Zeitschrift für Physik* (1934, **89**, 786), J. Mattauch and R. Herzog describe a new form of mass-spectrograph and the advantages it possesses over the forms used by Aston and Dempster. The focussing method of Aston utilises the prism-like action of the deviating fields so that ions of different velocity but same mass come together to a focus, when the initial direction of all the rays is the same. In the method of Dempster the lens-like action of a magnetic field is used to focus ions of the same velocity but issuing in different directions so that they come together. Now R. Herzog has

shown that a radial electric field or a homogeneous magnetic field act as a combination of a prism and a cylindrical lens (*Zs. f. Phys.*, 1934, **89**, 447). Hence if a canal ray containing particles of various masses and velocities is compared to white light, a combination of two such lenses should make it possible to obtain an achromatic image of the slit, *i.e.*, one focus for particles of the same mass but different velocities and directions. The authors now describe a form of mass-spectrograph which makes it possible to realise such a focussing. The canal rays proceeding in all directions from a slit are subjected to the action of a radial electric field and then to a homogeneous magnetic field in such a way that rays passing out in different directions and also containing particles of various velocities are brought to a focus at a single point. For special values of the angle of deviation by the electric field, the foci corresponding to particles of different mass lie on a straight line as in Aston's instrument. The form of pole-pieces is calculated in the paper. The advantages claimed for the new form of mass-spectrograph are the following:

(1) Since there is a focussing both with regard to directions and to velocities collimation by means of two narrow slits is not necessary and the canal ray beam will be more intense and the accuracy of measurement will be increased.

(2) Besides the greater sharpness and intensity of the lines, the resolving power for apparatus of similar dimensions is ten times as large as in the case of Aston's instrument.

(3) The mass-scale is simpler and easier to calculate than in the case of Aston's spectrograph. The distances of the lines from a fixed point are proportional to the square roots of the masses.

(4) The resolving power is the same all along the line of foci and for all masses.

(5) The angle at which the rays meet the photographic plate is the same for all masses and is much larger than in Aston's instrument.

(6) Since the angle of deviation by the magnetic field is only half as large as in the apparatus of Dempster or Bainbridge where it is 180° the strength of the magnetic field need not be so large.

The results obtainable with such an instrument would be interesting if all the conditions are realised in practice.

## On Demonstrations with very short Sound Waves and the Reaction of a Sound-Wave Field on the Source.

IN the *Physikalische Zeitschrift*, (1934, **35**, 524), E. Meier describes improved apparatus for demonstrating the properties of a field of very short sound waves. In order to increase the intensity of the radiation, a parabolic reflector having a depth equal to twice the focal length was used, so that more than half the energy of the source was converted into a parallel bundle. The reflectors were made of brass plate 1 mm. thick and had a diameter of 50 cm. When a grating made of two or six slits in a plate covered the opening of the reflector and the whole apparatus was rotated, the audience at successive positions could hear the sound when the diffraction maxima fell in their direction. For an objective demonstration sensitive flames were used. The flame was usually at the focus of a cylindrical parabolic mirror which served also to screen the flame from other influences. Useful forms of the burner for producing the sensitive flame are described. A brass tube of 8 mm. internal diameter tapers conically to a diameter of 2 mm. in a length of 40 mm. and the total length of the tube is about 100 mm. Such a burner is not too sensitive and is well suited for an auditorium. The shape of Galton-whistle was also modified to obtain a series of plane wave-fronts. The article contains a figure showing the new form. During the course of experiments with the apparatus described, it was found that a plane reflector placed at right angles to the parallel beam from the parabolic reflector influenced the state of vibration of the source. When the reflector was moved to and fro in front of a whistle served with a strong blast, the sound of the latter waxed and waned. In the case of a weaker blast some positions of the reflector could be found at which the whistle was completely silenced. If the ear is placed near the whistle one only hears a siffling of the escaping wind but no sound. The corresponding positions of the reflector are situated at intervals of $\lambda/2$. It appears as if the reflected wave interferes destructively with the vibrations of the air coming from the source. With a very weak whistle it was also possible to find positions of the reflector midway between the positions above described so that the sound was enhanced.

### Geochemistry of Living Matter.

THE progress achieved in Prof. Vernadsky's laboratory devoted to the study of biogeochemical problems, forms the text of a contribution by Uvarov published in a recent issue of *Nature* (1934, **134,** 11). A special laboratory devoted to the investigation of the geochemical rôle of organisms was created by the Russian Academy of Sciences in 1928, and in the short period of its existence, a number of valuable results have accumulated from the labours of Prof. Vernadsky and his collaborators.

The quantitative investigation of the chemical composition of living organisms has shown that certain organisms function as accumulators of definite elements; thus ants accumulate manganese and Lycopodiaceæ accumulate aluminium. The organisms which are geologically ancient possess the ability to concentrate a very wide range of elements. Vinogradov has, by means of a graph, demonstrated that every sixth element in the periodic table is of special significance to organisms.

Another important problem studied in the laboratory is the atomic weights of elements obtained from living organisms. The hypothesis propounded by Vernadsky in 1926, that living organisms possess selective powers in utilising isotopes of the elements, has been experimentally verified by Loving and Druce, who have shown that in potato, the isotope 41 of potassium predominates. In ordinary potassium, the chief isotope is of atomic weight 39.

These and several other problems relevant to the fundamental conception that living matter is a factor in the history of the earth, are being investigated in the laboratory under the inspired leadership of Prof. V. I. Vernadsky and important results which would establish closer relationship between the organic and inorganic worlds are awaited.

### Vitamin C and Amylases.

ON account of their relation to carbohydrate metabolism, Vitamin C and Amylase are both important in cancer research. The influence of Vitamin C (Ascorbic acid) on amylases forms the subject-matter of an important communication by Purr (*Biochem. J.*, 1934, **28,** 1141) from the Cancer Research Laboratory, Pennsylvania.

From a study of the effect on various animal amylases, Purr concludes that ascorbic acid possesses a specific activating influence on $\beta$-amylase at the optimum pH 6·8. The activation is linked with an increase in the transition point and in this respect is sharply differentiated from the activation by calcium salts and amino acids, where the transition is hastened but not affected. The activation of calcium salts and amino acids is observed only at a higher acidity (pH 5·1).

The effect of ascorbic acid on plant amylases is altogether different; an inhibition is observed in all cases. Plant $\beta$-amylases are strongly inhibited by reduced ascorbic acid but unaffected by the oxidised form, while in the case of $\alpha$-amylases, the activity is inhibited by the oxidised form but unaltered by the reduced form of ascorbic acid.

The author further observed that in the ripening grains—barley, rye, or oats—the $\alpha$-amylase is progressively inactivated, and this is probably related to the gradual decrease in Vitamin C observed by Virtanen and collaborators, during ripening.

### The Beech Bark Disease.

THIS serious disease, which has been known to exist in Europe since 1849, has, within the last fifteen years, been noticed to spread steadily and to cause extensive mortality among the beech trees in N. America and Canada. A disease survey, by Ehrlich (*Canadian J. Res.*, 1934, **10,** 593–692) who investigated this disease in Canada, showed that in two areas as much as 50% of the trees had been killed, and 90% of the stands infected. The external symptoms of the disease are manifested by the gradual drying up of the foliage and twigs, the loosening of the bark in patches, and the ultimate death of the trees.

The disease has always been associated with the appearance on the bark of a scale insect *Cryptococcus fagi* (Baer), which, by feeding, injures the underlying tissues of cortex and the phloem. The fissures thus caused, provide an entry for the fungus Nectria, which gradually invades the Phelloderm, Cortex, Phloem and Cambium. This sequential attack by the insect and the fungus which was long ago indicated by Boodle and Dallimore and later by Rhumbler, has now been definitely established by Ehrlich by inoculation experiments. Morphological and cultural studies of the fungus are described, and data given

on the height of ascospore discharge which takes place after rain. Neither the insect nor the fungus by itself when placed on the bark was able to produce the disease symptoms on the tree. Inoculations with the fungus on mechanically wounded or Cryptococcus infested bark always produced infection.

The fungus causing the American disease has been identified by Wollenweber as *Nectria coccinea* (Pers) Fries while the European species has been reported to be *N. ditissima* Tul.

The disease can be controlled on ornamental trees by the application of insecticides such as Carbolineum-Sunoco oil, or Kerosene-soap emulsion. In the forests, removal of dying and dead trees and the possibility of biological control are indicated as remedial measures. Growing of beech on broad ridge tops rather than on steep slopes, and early introduction of young supplies in place of old trees, are likely, in the opinion of the author, to mitigate the ravages of the disease.

M. J. NARASIMHAN.

### Biological Effects of Heavy Water.

E. NEWTON HARVEY has critically examined the results of previous workers on the effects of heavy water on animals and plants (*Biol. Bull.*, 1934, **66**, 2). It has generally been known that heavy water has deleterious effects on the growth of micro-organisms but the cause of this action is not known. It is observed that heavy water has no effect on the luminosity of *dried cypridina*, nor on freshwater luminous bacteria but diminishes the luminiscence and retards the growth of marine bacteria. Protozoans and rotifers are seen to become gradually slow in their activity resulting in death but *Euglena*, though affected by heavy water, recovers after favourable conditions are restored. A tentative theory has been advanced that the deleterious effects of heavy water are probably due to the accumulation of hydrogen peroxide.

### Chromosomes of Grasshoppers.

T. RAMACHANDRA RAO describes the structure and the behaviour of chromosomes in the spermatogonia of *Aularches* in a recent contribution (*Proc. Ind. Acad. Sci.*, 1934, **1**, 1). Aularches is a Pyrgomorphine grasshopper and possesses 19 telomitic rod-shaped chromosomes. During the several stages in the mitotic cycle they offer strong evidences for the chromonema theory as recently developed by certain plant cytologists. During the telophase processes the chromosomes gradually form vesicles, which show the presence of two thin intertwining chromonemata embedded in a lighter matrix. This observation also confirms the views of Robertson and McClung on the occurrence of telophase splits in Orthopteran chromosomes. The two threads gradually become very thin and finally pass beyond the limit of visibility. The interphase vesicles are quite independent of each other and during the prophase the characteristic spirals arise entirely within the limits of their own vesicles. The sex-chromosome offers striking pictures during the telophase when it is the first to diffuse and during the prophase when it is the last to re-condense.

### On the Morphology of the Epipubis, the Nobelian Bones and the Phallic Organ of *Ascaphus Truei* Stejneger.

PROF. C. G. S. DE VILLIERS in an interesting paper (*Anat. Anz.*, 1934, **78**) describes some of the hitherto obscure points in the morphology of *Ascaphus*. The sub-pelvic skeletal rods which were supposed to be cartilaginous are now shown to be bony; these Nobelian bones are not cartilaginous derivatives. The prepubic skeletal element is cartilaginous and finds a homologue in the epsiloid process of urodeles or the epipubis of *Xenopus*. In two other animals the presence of epipubis has been noticed, *Ascaphus* and *Liopelma*. The musculature and vascularization are described.

### Depth of Oil.

IN a recent number of the *Oil Weekly* (1933, **71**, No. 2), R. A. Jones has tried to answer the question 'How deep may Oil exist in the earth's crust?' For doing this he points out how necessary it is to know the depth to which porosity extends and proof of the existence of suitable rocks at that depth. In the light of the generally accepted geological estimates of the maximum thickness of sedimentary rocks, the author advances the idea that petroleum may occur in certain basins at depths of 20,000 to 30,000 feet below the surface.

### Plagioclase Determination.

R. C. EMMONS of the University of Wisconsin has published a very important paper on 'Plagioclase Determination by the Modified Universal Stage' in the latest number of the *American Mineralogist* (June 1934, **19,** No. 6). The paper describes a modification of Federov's Universal Stage which both simplifies and speeds up the procedure for the determination of plagioclase felspars and their twin laws. The actual technique of this work is explained in detail and amply illustrated in the paper. It is also suggested that the same procedure may be extended to an intensive examination of all minerals in which optic orientation is a good diagnostic criterion.

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## Marchese Marconi.

(Born 1874.)

IN the history of engineering endeavour of recent times, the name of no worker is so widely known as that of the distinguished Italian whose sixtieth birthday on April 25th was the occasion for tributes from every part of the globe wherever radio communication and broadcasting affects the daily life of the community. In contrast to those among scientists who insist that the pursuit of science is a form of self-expression and therefore an end in itself, Marconi has steadfastly adhered to the view that all scientific work has for its fundamental aim the promotion of human welfare and prosperity. His is the unswerving devotion of a life-time to the pursuit of the great objective of developing radio methods for the communication of intelligence between men and nations the world over. If his field of activity has been a small patch in the vast expanse of scientific and engineering endeavour, he has, nevertheless, been an intensive worker and a remarkably successful one. With the vision and courage of the pioneer, Marconi has worked persistently at his ideas undismayed by the scepticism of contemporary scientists and undeterred by the inevitable obstacles of vested interests.

His contributions to the development of radio communication are remarkably impressive in both volume and quality. They began in 1895 in early youth with his experiments in his father's garden, at a time when hertzien waves were yet a newly discovered scientific toy of the laboratory. But after Marconi entered the field, each year saw an increase in the distance bridged across, culminating in communication across the English Channel in 1895 and the wonderful and spectacular success two years later in bridging the Atlantic between Cornwall and Newfoundland. That great achievement of Marconi formed the starting point for the gigantic progress of the later years in the spread of world-wide radio communication, in which Marconi and his famous company have played so great and distinguished a part.

We owe him the earthed antenna, the improved and extensive use of the principle of tuning, the use of parabolic reflectors for directional working, and many others. The world does not now remember the rôle played by Marconi's improved coherers, his magnetic detector, the disc discharger, the timed spark and so on. Subsequent to the advent of that wonderfully versatile engineering instrument, the thermionic vacuum tube, Marconi and his able engineers have been responsible for the conception, development and inauguration of the first short wave directive system of radio telephony and telegraphy, which by its spectacular success has revolutionised long distance radio communication over the earth.

At sixty, Marconi is still active and has obtained during the last few years, interesting results in the use of extremely short waves of the order of a small fraction of a metre. It falls to the lot of few men to contribute so greatly to the growth of a world industry of such fundamental importance and to witness its phenomenal growth from a mere scientific toy to a dominating influence in the daily life of the world within the short period of four decades in their lives.

If honours from governments, honorary degrees from universities, membership of learned bodies in different lands and prizes and medals are any indication of a man's worth, Marconi has them in abundant measure. The Mussolini regime has elevated him to a hereditary Italian marquis, and he is the first president of the newly formed Italian National Academy, the highest

scientific body in Italy. Great Britain has given him sympathy and encouragement in his work in generous measure and on her hospitable soil Marconi achieved many of his striking successes; the Government of Great Britain created him a G.C.V.O. Equally abundant is the measure of publicity that his work and movements obtain in the popular press of many lands.

The increasing activities and prosperity of his company and its associates are alone sufficient to justify the hope that the years to come will witness further additions to his notable achievements and the wider spread of his fame as one who by his work as scientist and engineer has served humanity truly and well.

R. E.

## Molecular Spectra.

A SYMPOSIUM on the subject of "Molecular Spectra" was held in the chemistry hall of the Indian Institute of Science. All contributions to the symposium were received in full in advance, prominent among them being those from Prof. R. Samuel of Aligarh, Prof. Venkatesachar of Bangalore, Prof. K. S. Krishnan of Calcutta, Dr. Ganesan of Nagpur, etc.

In presenting his paper on "The Raman Spectra of Selenates and Selenic Acid", *Dr. Ganesan* discussed the dynamics of the $AX_4$ model representing the $SeO_4$-ion. In the state of solution the lines observed were 342, 415, 835 and 875, while for the crystalline state the same lines occurred sharper but with slightly displaced frequencies. From the data for the solution state and applying Dennison's formulas, the force constants for Se—O and O—O were calculated as 4·72 and 0·59 respectively. The heat of dissociation for Se—O was found to be 86 K. cal. while the corresponding value calculated from thermo-chemical and band spectra data came out as 95 K. cal. The spectrum of selenic acid differed from that of selenates, just as in the case of sulphuric acid and sulphates, there being a greater number of lines which relate now to the molecule $H_2SeO_4$.

An interesting discussion followed: *Prof R. Samuel* pointed out that the heat of dissociation cannot be entirely calculated from the Raman frequency alone, but a factor of anharmonicity in the vibrations must also be considered. The Raman effect at higher temperatures should show the presence of such an anharmonic factor. He also wanted to know whether there was any evidence for the existence of different kinds of Se—O linkages. *Dr. Krishnan* suggested that some of the discrepancies between the two dissociation values might disappear if due corrections were applied for the ionisation energy, etc., in the calculation of the thermal dissociation energy. *Prof. C. V. Raman* opined that the existence of only four lines indicated that the four bonds Se—O were identical, perhaps in particular for such slow infra-red oscillations. He referred to some earlier investigation by Bhagavantam on the Raman effect of benzene and carbon disulphide at higher temperatures, where no definite results were obtained. The lines should broaden out and any small shifts in the frequency will be particularly informative. *Prof. Venkatesachar* pointed out that he and Sibaiya had observed a shift of the centre of gravity of Raman bands to one side with rise in temperature. *Dr. P. Krishnamurti* remarked how the $SeO_4$ lines occur as two pairs, while the $SO_4$ lines are uniformly spread out. This is due to the heavier Se atom, and the phenomenon is similar in character to that observed with the heavier tetrachlorides as $SiCl_4$ and $TiCl_4$.

*Dr. K. R. Ramanathan* and *Dr. L. A. Ramdas* then presented a paper on the further extension of the ultra-violet spectrum of the sun. The present limitations due to the ultra-violet absorption band of ozone and of oxygen were analysed in detail, and it was shown that the heights accessible with pilot balloons must be sufficient for the object in view. Accounts of the spectroscopic methods of estimating the amount of ozone present in the atmosphere, and of calculating the height of ozone layer were also given.

A keen discussion followed in which *Prof. Raman* emphasised that generally in fitting a dispersion formula, the possible existence of bands in the extreme ultra-violet should never be neglected. *Dr. Ramdas* referred to the methods of determining the temperature of the ozone layer as being about 500°. *Dr. Ramanathan* in concluding the discussion complained that most reports about absorption spectra did not include sufficient details such as vapour pressure, temperature, etc., required to estimate the amount of substance employed, and consequently the published results could not be used for meteorological purposes.

*Prof. R. Samuel* presented a lucid account of the present state of knowledge regarding band spectra in general, and explained how a complete analysis of band spectra of diatomic molecules with the help of Franck-Condon diagrams, gives values of the dissociation energy in both the excited and unexcited states, and the harmonic and the anharmonic factors of inter-atomic forces. The anomalous cases where the energy of dissociation increases with the excitation state, and indeed so that the molecule in its ground state might consist of excited atoms, correspond to molecules with free valencies: the usual normal cases correspond to saturated compounds. The dissociation of molecules and their absorption spectra were then discussed and illustrated with the cases of $I_2$, CO, $CO_2$ and the silver halides, and it was particularly shown how AgCl in the vapour state must be a co-valent molecule, and not made up of ions like HCl. The absorption spectra of the alkali halides and of BeO and ZnO and the anomalous cases with free electron valencies such as NO, CaF, CdF, were described in detail, with their Franck-Condon diagrams. It was postulated in this connection that in crystals also, there are co-valent links between

molecules, and that such a postulate will explain the high melting point, etc.

The spectra of many triatomic molecules such as cadmium, zinc and mercury halides show continuous absorption. The atoms here are co-valently bound, while in $PbCl_2$ they can be shown to be electrovalently bound. The spectra of $SO_3$, $P_2S_5$, $PCl_3$, $Cl_2O$, $SCl_2$ were then described. They could be divided into two groups, the one such as $SO_3$, and $PCl_5$ in which the optical dissociation energy, $D_o$ is equal to the thermal value $D_T$, while in the other, such as $PCl_3$, $D_o$ is greater than $D_T$.

The vapours of organic molecules such as $CS_2$ show the phenomenon of predissociation. In $CH_3Cl$ and other alkyl chlorides, the continuous spectrum is independent of the alkyl chloride, but the band spectrum differs from case to case, and should therefore correspond to the c—x link. The calculated frequency for the link in the excited state is 1090, the corresponding Raman frequency for the unexcited state being 1210. From the spectra of ethylene dibromide, there is evidence for the interaction between the two C—Br linkages. After a brief account of the absorption spectra of organo-metallic compounds the speaker discussed the interesting results obtained with molecules in the state of solution. Here in many cases as with zinc iodide in alcohol the type of binding gradually shifts from co-valent to electro-valent with increasing dilutions presumably due to the influence of the dipole field of the solvent molecules. When other salts are added to the solution the positive or negative ions thus introduced cause characteristic shifts in the band maxima. The influence of the foreign ion can be either of the nature of a Stark effect or of a change in the internuclear distance.

The theory of complex salts was next considered and it was argued that there could be no co-ordinate linkages here, but only the usual type of co-valent links. There can be no octet rule in general, and all the phenomena of valence can be explained on the basis of different grades of the same kind of linkage, *viz.*, co-valent. There can be no single electron link, and the supposed co-ordinate link formed by the lone pair of electrons in the nitrogen atom is not possible, as these electrons are both of 2s type, and with a neutralised spin.

A brief discussion ensued, in which *Dr. Govinda Rau* pointed out that the evidences for the existence of co-ordinate links were quite considerable. The low dipole moment of CO, and the fact that Ni $(CO)_4$ had no moment pointed to the existence of a co-ordinate link between C and O, in addition to the ordinary double bond. With a few more questions by *Prof. Venkatesachar*, *Dr. Krishnan*, and others, the discussion was terminated.

*Dr. K. S. Krishnan* then presented an account of the extremely interesting results that he has obtained in collaboration with *Mr. Seshan* on the absorption spectra and fluorescence in single crystals of several organic substances containing a number of benzene nuclei and in potassium nitrate containing the flat $NO_3$-ion. The absorption in the two planes parallel and perpendicular to the flat molecules showed characteristic differences. This suggests that the quantum efficiency of photo-dissociation in such crystals may depend upon the polarisation of the light employed. A particularly interesting finding was that traces of impurities such as napthacene in diphenyl were also oriented in the crystal, and their presence was clearly brought out in the analysis.

*Mr. T. S. Subbaraya* reviewed the present position of our knowledge of the band spectrum of mercury and gave the results of a new vibrational analysis of five of the band systems which removed the discrepancies between the results of different investigators. A rather unusual fact pointed out by the author was that vibrational levels with vibration quanta which at first increased and then converged to zero were found in the common ground level of these bands which is accepted to be a $(^1S_o+^1S_o)$ state; the other results were, however, shown to be in accordance with theoretical expectations. Since a stable molecule with a strong binding was not to be expected in the case of van der Waals forces alone, the explanation of the levels revealed by the new analysis was to be the subject of further investigation.

In the discussion that followed *Dr. Samuel* remarked that since it is difficult to accept that the $(^1S_o+^1S_o)$ state could possess such vibrational states as those discovered by the author, one might possibly get over the difficulty by assuming the ground state to be a $(^3P+^1S_o)$ state and the others to be also $(^3P+^3P)$ states. *Mr. Subbaraya* replied that even here there would be difficulties since mercury vapour is known to be monatomic.

*Mr. Nagendranath* gave an account of the refined methods that he has developed for calculating the frequencies of tri-, tetra- and other poly-atomic molecules.

*Dr. M. A. Govinda Rau* then presented a paper on the comparative study of the Raman spectra of benzene and pyridine and the conclusions that could be drawn regarding the frequencies and modes of vibration of the benzene molecule. The trigonal symmetry of the benzene molecule was emphasised, and it was shown that the Kekule dynamic model for benzene was strongly supported by Raman spectra data. In a discussion that followed *Prof. Raman* and *Mr. Nagendranath* showed the mathematical difficulties in accepting these interpretations which are so widely supported by Kohlrausch and several others.

*Mr. S. Kulkarni Jatkar* gave an account of his experimental work on the Raman spectra of several organic compounds, and the elaborate precautions taken with regard to the purity of the substances employed such as cyclohexane.

Other papers presented to the symposium were taken as read. *Sir C. V. Raman* in winding up the symposium thanked the several contributors and those who took part in the discussions, and referred in particular to Prof. R. Samuel whose enthusiastic co-operation in the proceedings made the symposium such a great success. It was also announced that all the papers presented in the symposium would be very soon published in the form of a monograph.

M. A. G.

# Micro-Climatology in relation to Crops.*

By R. J. Kalamkar.

(*Agricultural Meteorology Branch, Poona.*)

IN a recent note[1] the importance and scope of micro-climatological studies were discussed. The present note is a continuation of the above with special reference to conditions inside crops as compared to those in the 'open'.

INFLUENCE OF VEGETATION ON MICRO-CLIMATE.

Not only does the climate of a place determine what crops or vegetation would thrive there but also the latter in their turn modify the climate and in particular the "micro-climate".

The influence of plants on "micro-climate" would depend upon the nature of plant surfaces, the convective processes in the neighbourhood of plants and the height and density of vegetation.

A surface of vegetation greatly alters the thermal conditions of the earth. Plant surfaces absorb solar radiation. A part of the absorbed energy is utilised in transpiration and photosynthesis while the rest of the energy goes to increase the temperature of the plant material which also loses part of the energy by emission of thermal radiation. Transpiration and evaporation from plant surfaces also play an important part in controlling the distribution of moisture in the air layers near the ground.

The convective processes in the neighbourhood of plants differ from those in the open. Inside vegetation air movements are feeble and loss or gain of heat by convective processes is correspondingly suppressed.

Apart from the direct effect of solar radiation on plants there is also the shading effect of plants on the surface of the soil according to the density of foliage. This decreases ground heating. The micro-climate is influenced by the height and density of vegetation and therefore by the stage of growth of a particular crop during the growing season. Four stages in the evolution of plant climate may be broadly distinguished.[2]

In the first stage the seeds have just sprouted, the ground is yet bare and so the micro-climate is not essentially different from that over bare ground.

In the next stage, there is a lateral spreading simultaneously with vertical growth, with complete shading of the ground. The seat of diurnal transfer of heat is still near the ground but the micro-climate differs from that over bare ground. The temperature range at the ground is now considerably reduced.

In the third stage plants grow in height and foliage is more uniform with height. An interspace between the ground and the surface of vegetation is also created. The top surface of the crop absorbs solar radiation during day and radiates heat during night. It therefore acts as a second active surface besides the ground.

In the final stage, *e.g.*, in case of a forest, the foliage near ground is less, the second active layer is raised farther from the ground and appreciable air movement is possible in the interspace.

MICRO-CLIMATIC OBSERVATIONS INSIDE CROPS.

Measurements of air temperatures and humidity at various heights are being taken daily inside a few crops and in the 'open' in the Agricultural Meteorological Observatory, Poona, at the epochs of maximum and minimum temperature by means of an Assmann Psychrometer. Observations in the 'open', jowar, and sugarcane, indicate that while pronounced differences are found in the micro-climates of these crops as compared to the 'open' at the epoch of maximum temperature, the differences are not so great at the epoch of minimum temperature.

MAXIMUM TEMPERATURE EPOCH.

It may be observed that at the maximum epoch, the dry bulb temperature in the 'open' is very high near the ground and falls rapidly with height during clear weather. Temperature inside jowar near the ground is lower than in the 'open', but at higher levels it is slightly higher than at corresponding heights in the 'open'.

In the case of sugarcane (an irrigated crop) the dry bulb temperatures near the soil are much lower than those in the open as well as those inside jowar (an unirrigated crop) and they have a tendency to increase with height, but even at 6 ft. it is about 2° lower than that of the 'open'. The largest difference between 'open' and sugarcane is 14°C. near soil, 5·5°C. at 2 ft., and 3°C. at 4 ft.

There is a tendency for vapour pressure to decrease rapidly with height and inside crops the moisture content is higher at all heights than in the 'open'.

MINIMUM TEMPERATURE EPOCH.

Variation of micro-climate is much less at the epoch of minimum temperature. The dry bulb temperature decreases at first with height both in the 'open' and inside crops and then begins to increase, the level of inversion being about 6″ in the 'open' and about 2 ft. inside jowar and sugarcane. Temperatures inside jowar and sugarcane are higher than in the 'open' but tend to the open air value at higher levels.

Vapour pressure in the 'open' is throughout less than that inside crops. In the 'open' as well as inside jowar it increases with height. In sugarcane, however, it decreases with height in the lower levels but variation is negligible after 3 ft. Vapour pressure inside sugarcane continues to be higher than in the 'open' and inside jowar at this epoch also.

CORRELATION OF MICRO-CLIMATE OF CROPS WITH THAT OF THE 'OPEN'.

It would also be interesting to investigate whether the conditions inside crops could be expressed in terms of those outside. If the correlations are high and significant, then past observations in the open may be adjusted so as to give conditions inside crops. Analysis of some of the results for tall crops show that the morning correlations of dry bulb, vapour pressure, wet bulb and relative humidity inside the crops with

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* Report of a lecture at the Colloquium, Meteorological Office, Poona, on the 26th June 1934.

[1] L. A. Ramdas, "Micro-Climatology," *Curr. Sci.*, 1933-34, 2, 445.

[2] Von Dr. Rudolph Geiger, "Microklima und Pflanzenklima," *Handbuch der klimatologie*, 1930, Band 1, Teil D.

those in the 'open' are uniformly high, whereas those for the afternoon are smaller, especially at lower levels.

Further studies on these lines and for different crops have to be continued at a few representative centres before definite conclusions could be drawn. The results obtained so far are being discussed in detail elsewhere.

## Agricultural Education in India.

By Dr. B. N. Iyengar, B.A., Ph.D. (Göttingen),
*Deputy Director of Agriculture, Bangalore.*

THE short note on the above subject by Mr. Agarwala published on p. 33 of July issue of the Journal tempts me to make a few observations.

Leaving aside the post-graduate institutions at Pusa and Bangalore mentioned by the author, all other institutions may be said to serve the purpose of training upper and lower subordinates to various Agricultural Departments in the country. Though Agricultural Colleges were established with a view to train up practical and scientific agriculturists, they seem to have failed to attract sons of the landed gentry who by virtue of their position and wealth may reasonably be expected to go back to their estates, run farms on modern lines and thus set examples to their tenants. Unless the Zamindars and large estate owners realise their duties towards their tenants and set an example to them by running a home farm themselves, agricultural improvement in this country may not go forward at a sufficiently rapid rate. It is well known that most of the agricultural improvements brought about in England and other European countries are mainly due to the efforts of landed gentry in those countries. Even to-day, it is private land-owners in England that are leading the country in the matter of stock as well as plant breeding. Even in the establishment of research institutions, private people gave the lead in England as is well known by the history of Rothamsted, the premier research institution of the world.

The course of studies followed in Agricultural Colleges of this country may be eminently suited to train good agricultural demonstrators for the subordinate services. Still it seems to be defective in a few essential points. The economics of agriculture are taught on farms where the plots are necessarily small and cost of cultivation consequently high. The practice in Europe is to ask students to go and work on private estates which are run on business lines and get certificates from the proprietors to the effect that the students have worked satisfactorily and understood the economics of crop production, management of labour, etc. Till such places of practical training are established by private persons in this country, it seems desirable for every Agricultural Department to run at least one farm on commercial lines making use of the successful results of all experiments to show their money value by practical demonstration and not merely by propaganda.

Such a step naturally brings with it a change in the course of studies. A theoretical course combined with practical demonstrations and plenty of workshop practice in modern agricultural implements and machinery should be the main feature in the early part of the course. The practical course to be followed later on must be devised for two kinds of students :-(*a*) sons of the landed gentry to enable them to go back to their own estates and become leaders in their respective areas, (*b*) people who desire to take up service as demonstrators, farm managers and such like.

At present, practical work such as ploughing, forms an examination subject and a certain amount of proficiency is expected in it. Such practical examinations should be modified to suit various types of students. Just as Engineers are not examined in the practical work of road making, trench digging, brick making, wall construction, mortar grinding, etc., too much stress on proficiency in practical field operations of agriculture does not seem to be necessary in the case of those who are to manage estates and are not expected to do the work themselves.

The second type of institution is the agricultural school where boys of the cultivating classes get a training in the theory and practice of agriculture. They are mostly vernacular schools. Even in these schools much time should not be spent on operations which the boys can learn from their elders on their own fields. As the European farmer says, boys must be taught things which they cannot learn in their own place, *e.g.*, about modern implements, new manures, methods of seed selection, etc. Even in these vernacular schools, a large majority of students seem to be from non-agricultural classes and go through the course simply with the object of getting into the lower ranks of service. Consequently, steps have to be taken to attract boys who will go back to cultivate their own lands and practise an intensive system of agriculture.

It would be seen from the above that the whole system of agricultural education needs to be overhauled to suit various types of students that are to be benefited by it.

## Himalayan Expeditions, 1934.

THE two Himalayan Expeditions, which attempted to negotiate the unconquered peaks of the Himalayas, have both been abandoned. The German Expedition, led by the well-known Herr Willy Mercle, was given up under tragic circumstances, the leader having met his end with three of his companions and a retinue of porters, before they proceeded very far. Another Expedition which was organised by the Indian Himalayan Expedition Club, did not materialise, as it is understood, necessary permission was not granted by the Government of India.

## International Commission on High Dams.

THE First Congress of this International Commission was held in Stockholm during June and July 1933. A number of very interesting papers were read by recognised authorities on the subject. These have now been published as the Proceedings of the First Congress in five volumes under different sub-heads. A short review of the papers dealing with the sub-head "Study of Physical Laws Governing Infiltration of Water through Earth-field Dams or Masonry Weirs on Sand Foundation", is given below.

With regard to the different forms in which the water appears in the earth, the classification adopted by Zunker[1] is mentioned and in connection with the same it is observed that the following forms with reference to the movement of water in dams must be examined:

1. The true seepage flow, that is to say, the movement of water which takes place exclusively under the influence of gravity and friction.
2. The capillary seepage flow in which, in addition to gravity and friction, capillary forces affect the movement.

The first case occurs when the flow is below a masonry weir under sand foundation or such other cases where there is no free surface of water in the sand medium. The seepage flow is a potential flow and can be treated mathematically according to the laws of potential theory.[2] As is shown by many tests[3] Darcy's Law holds good for this movement. Special emphasis is given to the electrical method[4] of investigation, which can, if necessary, be supplemented by trials with dam models through which water is flowing. The theoretical flow process can be completely and fully deduced from a complete flow diagram showing the network of flow and potential lines. The volume[5] of water flowing below a masonry floor can also be calculated.

When the medium through which water is flowing is not homogeneous the problem is more difficult; however, one can arrive at the movement of the water within each homogeneous layer. In addition to the usual boundary conditions which obtain with soils that are homogeneous throughout, there must also be taken into consideration the condition for the transit of water from one material to another. The model rule[6] that must be complied with, in such cases in order to achieve similarity of stream line diagrams both in the model and the prototype, is that the ratio between the coefficient of permeability of the individual layers under the model to be in strict conformity with that of the corresponding strata in nature.

Two types of flow are to be distinguished in connection with the capillary seepage flow:—

(*a*) The accompanying capillary flow—this refers to that movement of the water which occurs in the strip of soil that lies above the zone of the free seepage flow.

(*b*) The capillary seepage flow—in this case the water is always free, that is to say, it does not fill the whole of the pore space.

The laws governing these types of flow are still entirely unknown. For the builder of earth-filled dams, it is above all things very important to know the correct position of the seepage line. It has been shown[8] that for simple cases the theoretical flow diagrams agree with the conditions in a model and one may expect that this agreement will be maintained to a sufficient degree in the actual dam. It is stated that the capillary flow acts quite differently in the model and the prototype and as a result the laws for model naturally lose their value unless it is possible to apply the same model laws for the capillary flow. This would be possible if a liquid is used in the model the capillary elevation of which was equal to $1/n$th ($n$ the scale ratio of the model) of the capillary elevation in the soil of the prototype.

N. K. BOSE.

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[1] F. Zunker, *Handbuch der Bodenlehre*, 1930, **6** Bd.

[2] Ph. Forchheimer, *Zur Grundwasserbewegung nach Isothermischen Kurvenscharen*, Wien, 1917.

[3] Th. Rehbock, "Sickerwasserbewegung im Erdreich." *Proceedings of the First Congress of High Dams*, 1933.

[4] N. N. Pavlovsky, *The Theory of Groundwater-flow under Hydrotechnical Structures*, U. S. S. R. Leningrad, 1921.

[5] T. Schaffernak and R. Dachler, *Versuchstechnische Lösung von Grundwasserproblemen.*

[6] R. Dachler, *Uber Sickerwasserströmungen in geschichtetem material.*

[7] B. Korner, *Erförschung der Physikalischen Gesetze, nach welchen die Durchsicherung des Wassers, durch eine Talsperre, order durch den Untergrund stattfindet.*

[8] R. Dachler, *Der Sickervorgang in Dammböschungen.*

## International Conference of Physicists.

UNDER the auspices of the International Union of Physics and the Physical Society a Conference will be held in London in October, Professor Millikan and Lord Rayleigh presiding. The business of the Conference will include a discussion on nuclear physics, and a discussion on certain aspects of the theory of the solid state of matter. There will also be presented to the Conference a report from the Symbols, Units and Nomenclature Commission of the International Union of Physics. By the courtesy of the President and the Managers of the Royal Institution, the London meetings will be held in the Lecture Theatre of the Institution. At the invitation of Lord Rutherford the Conference will meet one day at the Cavendish Laboratory in Cambridge. Among the social events of the week will be included a reception by the President and Council of the Royal Society and a visit to the National Physical Laboratory.

# Science Notes.

*Al-Kindl's Theory of Colour of the Sky.*—Mr. Zaki Uddin of the Muslim University, Aligarh, writes:—"C. Brockelmann (*Gesch. der Arabischen Literature*, Vol. I, p. 209) has mentioned only a few of the surviving manuscripts of the great Arab Philosopher and Scientist Yaqub b.Ishaq al-Kindi, who has written about 300 treatises on various subjects of science and other branches of knowledge. Out of these manuscripts one No. *MSS. Sed. Arch.*, A. 32, p. 374, preserved at the Bod. Library at Oxford and at Constantinople Aya Sofya Library MSS. No. 4832 is not only important for a student of modern science but also interesting. This MSS. deals with the explanation of the blue colour of the sky, and is the first manuscript available for adding to our knowledge regarding the theory of colour between the age of the Greek Speculators and the famous Arab Scientist, Ibn-al-Haitham (Alhazen with Latin name). Although a number of speculations regarding the cause of the colour of the sky can be found scattered here and there, it was not before al-Kindl that an authentic explanation was given. The important treatise of Aristotle (Opuscula, Oxford 1913) dealing with the General theory of colour does not contain much about this problem.

"Recently the MSS. has been edited and translated into English by Prof. Dr. O. Spies, Professor and Chairman, Department of Arabic, Muslim University, Aligarh, and by me. The translation reveals a number of interesting points and it would be worthwhile to consider and compare the 'old crude ideas' of the ancients with the modern view.

"We know to-day that the colour of the sky is due to the dispersion of the rays of the sun by the atmosphere. This is the result of the investigation of the modern physicists."

When we read in the manuscript of al-Kindl the following, we cannot but appreciate 'one of the twelve greatest minds of the world' (according to Cardano):—

"Now above us, shadowy air has become visible on that what light of the earth and the light of the stars mixes colour in the middle of the shadow and light and that is the blue colour. So it is evident that this colour is not the colour of the sky but it is a thing which is exposed to our sight."

A detailed account of the theory of colour of al-Kindl with the original text and translation will be published elsewhere.

(It would be worthwhile to draw the attention of the students of optics interested in the work of Ibn-al-Haitham to the Corpus of al-Kindl's works discovered by H. Ritter (*Archiv Orientelni*, Prague, 1933, pp. 363–372) and by me at the Oriental Library at Patna dealing with the theory of propagation of the rays of the sunlight. The later MSS. entitled "risāla fī mutārih ash-shua" is a copy of an older MSS. of the "madrasah al-Kamilia" at Cairo, and was copied in the 8th century A.H. It would be interesting to publish a translation of the same.)"

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*Earthquake in the Panama Canal Zone.*—An earthquake shock of great intensity at its origin about 10,200 miles from Bombay was recorded by the Colaba seismographs at 7 hrs. 26 mts. I. S. T. on Wednesday, the 18th July 1934. It appears from the newspaper reports that the shock originated near Costa Rica in the Panama Canal Zone. The earthquake is reported to have caused considerable loss of life and damage to property. A concrete work recently built at a cost of £ 60,000, in Puerto Armuelles was completely destroyed.

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*Asiatic Society of Bengal.*—An ordinary meeting of the Asiatic Society of Bengal was held on Monday, the 6th August. One of the interesting papers that was presented before the meeting was on the "*Saddharmapaundarika*: A Collection of Central Asian Memoirs of the Lotus of the True Law", by N. Miranov. From his study of the different sets of the Central Asian Manuscripts, the author distinguishes, according to the script, two groups of manuscripts: (1) Those in the *Upright Gupta* Script, and (2) those in the *Calligraphic Upright Gupta* Script. "From the comparison of the different sets with other Central Asian Manuscripts and with the Indian epigraphic monuments, the author assigns the first group to the 5th-6th centuries, and the second one to the 7th century. A comparison with Chinese versions permits to assign the recension of the text represented by the 1st group to the 3rd century A.D. and the text of the Calligraphic Upright Manuscripts to the 6th century. Up to the present chiefly manuscripts of the latter group have been published or made use of (like the manuscript of the Bibliotheca Buddhica Edition studied by Kern), those of the first one are comparatively little known.

"The present collection contains the remains of *three* manuscripts in the Upright Gupta Script, whereof one (A = 12N°N° or 25 Frgg.) belongs to the oldest stratum (middle of the 5th century), while the two others (B and C=20N°N° or 31 Frgg.) are slightly younger going back to the 6th century. The manuscript in the Calligraphic Upright Gupta (D) is represented but by 2N° N° (=7 Frgg.).

"The author has added, in an appendix, the edition of *five* Frgg. of the 'Lotus' from the *Stein* Collection (India Office Library, London), of which two (S. I, S. II), written in the Upright Gupta Script, are three almost complete leaves, while the rest are important from the literary point of view, giving nearly the same text as some Frgg. of the Otani Collection.

"The author has, in his paper emphasised the far-going deviations of the Central Asian recensions, as far as the language is concerned. The manuscripts in the Upright Gupta Script are written throughout in mixed or Buddhist Sanskrit, *i.e.*, represent a Prakrit base overlaid with a faint Sanskrit varnish. Considering the importance of this form of speech of which no Buddhist text is free, the author has compiled a grammar of his texts dealing with both the Phonology and Morphology; he has tried to assign the proper place among the Prakrit languages to the dialect to which Buddhist Sanskrit goes back. Such a grammar will be useful to any student of Buddhist literature, a systematic treatise on the subject being badly lacking. Our present knowledge of Buddhist Sanskrit is confined to a few accidental notes in the editions of Buddhist

texts (not to speak of Rajendralala Mitra's work of the early eighties which is out of print)."

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*An Unusual Meteor.*—Mr. Zaki Uddin of Aligarh University writes: On Monday, the 23rd July 1934, at 9-30 p.m. an unusual meteor appeared above the clouds that hovered over the horizon of Aligarh. The meteor started from South-West and travelled South-East at about 50° with unusual brilliance, lighting the ground for about 15 seconds. At the beginning it appeared like a ball of fire, that afterwards developed a source of extraordinary light. Later on, it began to emit bright bluish light, and just before disappearing increased in brilliance and split into two portions at about 20° from horizon. It is said to have fallen near Hapur about 40 miles from Delhi. This phenomenon observed was extremely abnormal.

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*Sugar Industry in India, 1932-33.—Review by R. C. Srivastava.*—During the last few years the sugar imports to India have rapidly declined as a result of the growth of Indian sugar industry which has increased the production of white sugar under the very favourable protective tariffs. Almost coeval with the rise of factory industry the 'Khandasari' or open pan system has also expanded and its productive figures have been mounting in the recent years. Results on the agricultural side are also marked. Although the acreage under cane has increased by 10% cane production itself has risen by about 30% which is due to the increasing adoption of improved varieties of cane. An examination of the sugar production figures for the last thirteen years shows the beneficial effects of the tariffs on the industry which has suddenly increased the output of sugar at the closing years of the said period. Also there has been an increase in the number of new factories erected for operation.

Technical and scientific work on cane breeding at the Coimbatore Station has produced several improved varieties of cane now being adopted in the different provinces with success. Some of the varieties CO 281 and CO 290 have been recognised in Queensland and Natal as disease-resisting. Among the other varieties may be mentioned CO 213 in U.P., CO 205, 223 and 285 in Punjab, CO 213 in Madras which have been extensively grown and found to be very satisfactory in the respective provinces.

Total sugar machinery imports during 1932-33 exceeded a crore and a half rupees, nearly two thirds of this amount being spent on British machinery alone. Among the 58 newly erected factories two plants have been entirely built in India and are quite up-to-date.

Due to the recent expansion of the home industry not only have the imports of sugar, both by land and sea, diminished and total home production risen, but there was practically no import of gur or jaggery from neighbouring countries. Java has suffered in her sugar trade by the Indian import duties as also by the Sino-Japanese conflict in Manchuria and England's relinquishing of the Gold Standard. As a result of the accumulation of large stocks measures of restriction of production and centralisation of selling control were adopted. Cuba also had to face a severe disappointment as even the Chadbourne agreement failed to raise the level of prices and Cuba losing a large share of her American market had also to close down 50 out of 183 centrals. As compared with the previous year there was a decline of 3·2% in the total world sugar production there being a 16·4% fall in Europe's beet sugar alone in 1932-33.

The prospect of Indian Industry is hopeful especially in view of the check which the fear of an unhealthy expansion of the industry under very favourable tariffs has received from the new excise duty levied by the Government. The problem, however, of raising the Indian sugar consumption which has remained at a very low figure has still to be faced, otherwise the industry is threatened with the evil of over-production in the course of a few years.

* * *

According to a report in the *Chemical Age* the Maharaja of Kolhapur has granted to a British Syndicate the monopoly of commercially utilising the mineral deposits of the State, especially bauxite. The Syndicate will be formed by the promoters of the scheme and it is said that Sir Basil Blackett will be the Managing Director. An important Aluminium Industry may come into existence in the State.

* * *

A joint meeting of the Society of Biological Chemists, India, and the Grant Medical College Physiological Society was held on Friday, 27th July 1934 at 3–30 p. m. in the Physiology Theatre of the Grant Medical College when Prof. R. H. Dastur read a paper on "The Chemical Mechanism of Respiration".

Major S. L. Bhatia, Dean of the Grant Medical College, presided.

* * *

*Biochemical Society, Calcutta.*—With the object of the promotion of biochemical studies and research a Biochemical Society has recently been formed at Calcutta. The Society was formally inaugurated on the 6th July at the All-India Institute of Hygiene and a paper on the "Metabolism of Carotene" by Dr. B. Ahmed was read. It has been arranged to hold monthly meetings for biochemical discussions and reading of original papers, reviews, etc.

The first Committee of the Society has been composed of the following:—

Prof. N. M. Basu, Lt.-Col. T. C. Boyd, Prof. Sudhamoy Ghosh, Prof. J. N. Mukherjee, Dr. B. B. Sen, Prof. H. K. Sen, Prof. H. E. C. Wilson, with Dr. B. C. Guha as Hony. Secretary and Dr. B. Ahmed as Hony. Treasurer.

The Society has already evoked an all-round response as the lack of a common meeting ground has been felt for some time by the local workers, and successful meetings are being held. It is hoped that the Society will help to advance the cause of Biochemistry in India.

* * *

*Royal Institute of Science, Bombay.*—Mr. K. H. Vakil, Member of the Advisory Board of the Institute, specially visited the Institute to inspect the research equipment.

The Institute was closed on 27th July as a mark of respect to the memory of Sir Cowasji Jehangir (Sr.) whose death took place on 26th July at Poona. The late Sir Cowasji Jehangir was one of the three leading persons responsible for the foundation of this Institute, donating altogether about Rs. 7½ lakhs. A condolence

resolution was passed at a meeting of the staff and students.

Prof. Gunjikar (Prof. of Mathematics) is proceeding on a short leave out of India. Mr. S. D. Manerikar, B.A. (Cantab.), will work during his absence on leave.

Dr. N. R. Tawde, B.A., M.Sc., Ph.D. (London), A.Inst.P., is appointed Lecturer in Physics.

* * *

*Calcutta University.*—It is understood that Mr. Syama Prasad Mukherjee, son of the late Sir Ashutosh Mukherjee, has been appointed Vice-Chancellor of the Calcutta University, in place of Sir Hassan Suhrawardy whose term of office expires this year. It is also understood that the Syndicate of the University have recommended that the degree of *Doctor of Science* be conferred on Sir Suhrawardy, retiring Vice-Chancellor, at a special convocation to be held at the Government House in the first week of August.

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Prof. H. E. Watson, lately Professor of General Chemistry, Indian Institute of Science, Bangalore, has been appointed to the Ramsay Memorial Chair of Chemical Engineering at University College, University of London, in succession to Prof. W. E. Gibbs.

* * *

The Tenth International Exhibition of Inventions will be held at the Central Hall, Westminster, London, from October 3 to 13, this year.

* * *

*German Association of Men of Science and Physicians.*—According to a report appearing in *Nature*, the Ninety-third Meeting of the Association will be held at Hanover on September 16—20. "This is the first meeting under the new constitution and an impressive proclamation of German Science is desired. Exhibitions and Excursions are planned. The Exhibition dedicated to 'Deutsches Volk—Deutsche Arbeit' is to give a picture of the history of German race with emphasis on heredity, genetics and eugenics and also on Chemistry as a domain in which intellectual leadership is fundamental for industry."

* * *

*Scripta Mathematica Library.*—Scripta Mathematica has in the course of preparation a series of small volumes to be known as "The Scripta Mathematica Library". This series will deal with the history and philosophy of Mathematics and with its relations to the other great activities of the human spirit. Each volume will contain at least 96 pages. Some of the proposed titles are:—(1) Poetry and Mathematics and other essays—by David Eugene Smith; (2) Mathematics and the question of Cosmic mind with other essays—by Prof. Cassius Jackson Keyser, and (3) Fabre and Mathematics and other essays—by Prof. Leo. G. Simons.

Scripta Mathematica also offers to any Library in India, *free of charge*, the following pamphlets. (1) Thomas Jefferson and Mathematics—by David Eugene Smith, and (2) The Meaning of Mathematics—by Cassius Jackson Keyser.

* * *

*The Progress of Radio Research*: Report of the Radio Research Board for the period, 1st January 1932 to 30th September 1933. His Majesty's Stationery Office, Price 2*s*. 6*d*. net. (Post free 2*s*. 9*d*.)

Knowledge of the work carried out under the Radio Research Board of the Department of Scientific and Industrial Research is essential to anyone wishing to keep abreast of advances in research on the propagation of waves, direction finding, atmospherics, and improved methods of measurement at radio frequencies. The progress of the Board's investigations on these subjects is summarised fully in the recently published Report.

* * *

A new reaction for cantharidine, applicable to its estimation by colorimetry has been described by Georges Deniges in a paper communicated to the Academy of Sciences, Paris. The method is based on the colouration produced by heating cantharidine with formol and sulphuric acid.

* * *

In a paper communicated to the Academy of Sciences, Paris, Vellard has described his observations relating to the periodic destruction of the fauna of the rivers of the Grand Chaco by variations of salinity. "The fish die as the salinity increases through evaporation and are deposited in enormous blocks. This is of interest from the geological point of view as it gives a possible explanation, better than any other hypothesis, of the formation of certain banks of fossil fishes, the origin of which is otherwise difficult to understand."—*Nature.*

* * *

*A New Ceramic Ware of Water Absorption of Nil.*—"No property of Stoneware," says Felix Singer (*Chemical Age*, 1934, **30**, 553), "is of such decisive importance for many of the purposes of the Chemical Industry as its degree of water absorption." The production of a new English ware "Alchemie" (by Doulton and Co.,) with no absorption at all, can therefore be considered as an achievement of first importance in Chemical Industry. In spite of the reputed and resisting properties of Stoneware, its extensive use was limited by the water-absorbing property it possesses. The production of "Alchemie" has now made possible the employment of the ware, freely, in foodstuff industries, in all processes where use is made of hydrogen peroxide or other *per* compounds, in the manufacture of taps and such other plant accessories, in chemical works and in several other industries where stoneware is usually considered the best, nay, the only material that can be used for certain apparatus.

* * *

We acknowledge with thanks the receipt of the following:—

"Nature," Vol. 133, Nos. 3371 to 3375.
"The Chemical Age," Vol. 30, Nos. 780 to 784.
"Canadian Journal," Vol. 10, Special Number and No. 6.
"The Journal of Chemical Physics," Vol. 2, No. 6.
"Berichte der Deutschen Chemischen Gesellschaft," 67 Jahrg, Nos. 6 and 7.
"Natural History," Vol. 34, No. 4.
"Journal of Agricultural Research," Vol. 48, Nos. 5 and 6.
"Experiment Station Record," Vol. 70, No. 5.
"American Journal of Botany," Vol. 21, No. 6.
"Journal de chimie Physique," Tome 31, No. 5.
"Science Progress," Vol. 29, No. 113.
"The Science Forum," Vol. 1, Nos. 1 and 2.
"The Journal of Nutrition," Vol. 7, Nos. 1 to 6.

"The Review of Scientific Instruments," Vol. 5, No. 6.
"Scientific Indian," Vol. 11, No. 66.
"Indian Forester," Vol. 60, No. 7.
"Medico-Surgical Suggestions," Vol. 3, No. 6.
"Forschungen und Fortschritte," Jahrgang 10, Nos. 17, 18 and 19.
"Journal of Agriculture and Livestock in India," Vol. 4, Part III.
"The Indian Journal of Veterinary Science and Animal Husbandry," Vol. 4, Part II.
"Indian Forest Records," Vol. XX, Part 6 (Entomological Series).
"The Indian Trade Journal," Vol. CXIII, No. 1462 and Vol. CXIV, Nos. 1463 to 1465.
Govt. of India Publications: "Forest Bulletin" No. 83 (Sylvicultural Series) 1934.—Provisional yield Table for *Quercus incana* Roxb.
Department of Commercial Intelligence and Statistics in India: "Monthly Statistics of the Production of Certain Selected Industries of India," March 1934, No. 12.
"Journal of the Institute of Brewing," Vol. XL, No. 7.
"Scripta Mathematica," Vol. 2, No. 3.

## Reviews.

RASSENKUNDE UND RASSENGESCHICHTE DER MENSCHHEIT. By Egon Freiherr von Eickstedt. (Stuttgart. 1934). Price RM. 76·50.

The number of really authoritative text-books on Anthropology issued so far is relatively small and it has, therefore, been a matter of great difficulty for workers in this science to get together the necessary information except by wading through a great deal of scattered literature in not easily accessible scientific periodicals and various manuals. Martin's "Lehrbuch" of which a second edition was published in 1928, Saller's "Leitfaden der Anthropologie" (1930) and Wilder's "A Laboratory Manual of Anthropometry" (1920) are amongst some of the most authoritative publications, but still there was the necessity for an up-to-date and carefully prepared work dealing in detail with the very important questions of the different races of mankind and their history. Such a work is the one under review, published by Prof. von Eickstedt of Breslau University. This handbook differs from the older works in that it contains as exact and detailed an account as possible of the complicated question of the races of mankind, based on a careful study of the extensive literature and the personal researches of the author not only in the laboratory but also in different continents. In addition to dealing with the races under four major groups, *viz.*, Asiatic, European up to Sahara, Negroid Africa and Oceania and the two Americas, the author has dealt with in detail the development of the various epochs of the history of the different races and their connections with the continental and other changes. The author carried out a great deal of anthropometric measurements of the various races and more particularly of the primitive tribes of India, and though one may not agree with all his conclusions, the information in reference to these tribes, which is incorporated in the volume, would prove invaluable to students of Anthropology in India.

The publication is beautifully illustrated and the large number of specially prepared maps add greatly to the value and importance of the work. It should create a great deal of interest in anthropological studies for the carrying out of which correct lines are indicated.

B. P.

ELEMENTARY DYNAMICS. By R. C. Gray, (Macmillan & Co., Ltd., pp. xi+211, 1931.) Price 5*s*.

The author in his preface states that the book is intended for students beginning a University course in engineering or other applied science and that the subject is treated as an introduction to applied science and not as a branch of mathematics. The book deals in a particularly clear and simple manner with the essential portions of particle and rigid dynamics. The introduction of a few of the topics usually dealt with under statics and a chapter on gyroscopes form a welcome innovation. The treatment is anything but hackneyed and there are very few books of this sort which keep an eye to the practical applications of Dynamics in Engineering. The examples have been very carefully chosen, but one cannot get over the feeling that the majority are unnecessarily too numerical.

In such a well-trodden field where there is a bewildering variety of text-books differing from each other in their content as well as method, it is very difficult to assess the value of any new book on the subject. This book, based as it is on the syllabus of

Prof. Gray's lectures in the first year course at Glasgow University, maintains a wholesome balance between clarity and comprehensiveness. Although the author has not used the calculus explicitly, he makes skilful use of the conceptions of the calculus in deriving the important principles. The Chapters on Friction and on Work, Power and Energy are particularly well written.

The get-up and printing of the book are excellent and the price too is quite reasonable. It can be safely recommended as an excellent introduction to Elementary Dynamics specially suited for the Engineering and Pass courses in Mathematics of our Universities.

B. S. M.

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THE PRACTICE OF ABSORPTION SPECTROPHOTOMETRY. By F. Twyman, F.Inst.P., F.R.S., and C. B. Allsopp, M.A., Ph.D. 2nd edition. 144 pp. Royal 8vo. 40 illustrations, bound in cloth boards, June 1934. 12*s.* 6*d.* nett, 12*s.* 9*d.* post free. (Adam Hilger, Ltd. London.)

The subject of absorption spectroscopy has assumed such importance in both theoretical and applied chemistry that it is pleasant to record that, although it is only a little more than two years since the first edition of this book appeared, it has already been found worth while to publish a new and completely revised edition. The book has been entirely recast and enlarged. The present edition is divided into two parts, the first of which contains an introduction to the theory of absorption, including a simple description of molecular spectra, and an account of various typical applications of absorption spectroscopy, in which the interests and requirements of the theoretical, industrial and biological chemist have each been kept in view. An attempt has been made to introduce a much-needed uniformity in the nomenclature of absorption spectroscopy by adopting that set out in the International Critical Tables of 1929, a step which could profitably be followed by all workers in this field.

In Part II, the technique required in photometric measurements of absorption is described and explained. A chapter in this section discusses the conditions which are necessary for obtaining accuracy in the various types of measurement involved, and this is followed and illustrated by a detailed account of the principles and use of typical instruments which have been developed by Adam Hilger, Limited, for spectrophotometry in the ultra-violet, visible, and infra-red regions of the spectrum. One of a number of appendices describes a new method of applying absorption methods in the textile industry which may have far-reaching consequences. The book will be of interest to workers already engaged in absorption measurements; while to those to whom the subject is new and who are contemplating such work it will be invaluable. It could also be read with profit by advanced students, both on the theoretical chemical side, and on the technical side of the subject.

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SATELLITE STATION TABLES. By C. M. L. Scott. (Edward Arnold & Co., London, pp. 44.) Price 12*s.* 6*d.*

Satellite stations are a necessity in unsuitable country, where it is not practicable to choose main direct stations. Owing to the tedious calculations involved in the so-called "Reduction to centre", endeavours are sometimes made to avoid satellite stations. As a result, labour and time are spent to alter the main stations, while trying to choose places where instruments can directly be set up in preference to desirable prominent points that necessitate observations from a satellite station.

The author of this volume has done great service to the Surveyor. He has, by the publication of these tables, enabled saving of time and labour involved in "Reduction" where "False Stations" are introduced and has at the same time made possible a free choice of suitable satellite stations. The tables can be used for easy and quick reduction, without, what is more important, sacrificing accuracy. Where very great accuracy is not required, a further saving in time and labour in reduction to centre can be made by the use of the graphical method explained in Appendix I. With the help of the disc enclosed in the pocket at the end of the book, corrections and the signs of corrections to be applied to the observed angles, to get the angles at the True Station, can be rapidly got. The graphical method is particularly useful where many readings from the same satellite station have to be reduced.

A variety of problems can be solved by the use of Satellite Station Tables with ease. Several worked out examples are given in Appendix I indicating the use of these tables in the solution of Survey Problems and it will readily be seen that the use of these

tables can be easily extended to a number of other problems. The wide applicability of these tables enhances the usefulness of this book.

The book is well written and the preparation of the Tables must have entailed great labour. The work of the publisher is good and the volume is sure to be an useful addition to the Library of a Surveyor or an Engineer.

K. D. JOSHI.

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TELEVISION: THEORY AND PRACTICE. By J. H. Reyner. (Published by Chapman & Hall, Ltd., pp. x+ 196.) Price 12*s*. 6*d*.

Although Television has not yet become a commercial success, it is doubtful if there is any other field which has caught the fancy of both the amateur and the layman. It is but natural that such an interesting subject should call the attentions of Radio Engineers and Experimental Physicists to supply the necessary fundamental knowledge to the general public. Mr. Reyner's book is an answer to this call.

It is rather an ambitious programme to condense all the theory and practice of this vastly interesting field in a small volume of less than 200 pages, for Television, unlike its sister science, lays claim over a vast domain of Experimental Physics. An attempt to bring together all these, in a small space, naturally involves an elaboration of certain points, and a scanty reference, if not a complete neglect of other equally important branches. It is remarkable, however, that the author has cleverly managed the situation. By completely omitting to mention certain old devices which are now more or less historical, or only attract the attention of the curious, he has emphasised the more important principles involved in Television.

The book opens with a general definition of what television is. The methods of scanning, and the factors that determine the detail, and clearness of television pictures are briefly discussed. A complete chapter is devoted to a description of the eye, and other optical arrangements without which no book on television can be complete. Next, the author deals with Photo-electric cells; the real backbone of television transmitting apparatus. While there is adequate matter to serve as a good background to the proper understanding of the subject, one feels that sufficient importance has not been given to this very important item. Then we come to what is perhaps the most important part of the text, namely, the 'Cathode Ray Tube'. The treatment of this is worthy of praise. The construction of the cathode ray tube, and its practical application to television have been given all the importance they deserve; no doubt in view of the fact that the cathode ray tube has to play an important rôle in television receiver of to-morrow. There is also a chapter devoted to the television receivers, in which the performance of resistance-coupled amplifiers and direct coupled amplifiers are briefly discussed. The rest of the book gives a fleeting review of Continental and American systems that are in vogue to-day. Finally the book closes with a brief but critical review of all that has been achieved in the field till now; and the visualisation of what it is going to be in future is resplendent with a rosy optimism. The get-up of the book is of a high order, the photographs and diagrams are adequate, and help to elucidate the text. The book can be confidently recommended to all those interested in this vastly absorbing field.

C. C.

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UNIT PROCESSES AND PRINCIPLES OF CHEMICAL ENGINEERING. By John C. Olsen, Ph.D., D.Sc. (Macmillan & Co., Ltd., pp. xiv+558.) Price 25*s*. net.

This co-operative work by a group of successful American Chemical Engineers is a valuable addition to the not very large number of up-to-date text-books available in the field. The book has been developed by presenting the fundamental physical and chemical principles determining the course of a chemical reaction and a few of the unit processes which must be utilised in carrying out a given reaction on a commercial scale with a combination of some of these processes in their proper order constituting thereby an entire process for the production of a given product.

It is not attempted to make the book exhaustive by a presentation of all the different possible unit operations but to emphasise only on the fundamental aspects brought up-to-date of a few of the most fully studied and well-developed processes like Evaporation, Distillation, Filtration and Drying. The supplementing of a knowledge of the remaining Unit Operations has been left to the reader for a further

study on the lines indicated during the course of the book.

A special feature of this volume is the inclusion of separate chapters on modern processes like the Absorption of Gases, Electric heating and the Electrolysis which are being systematically employed in industrial practice to an increasing extent. The Editor must be congratulated on his wisely incorporating into the book the concluding chapters on the all-important subjects like the materials of construction, costs and financing and Factory Location in that they bring out clearly the importance of a knowledge of Applied Economics to a Chemical Engineer in his daily routine. Most of the chapters contain at their end a set of well-selected problems illustrating and developing the ideas detailed in each chapter with also a short bibliography guiding the reader in the choice of books to secure a more exhaustive knowledge of the subject.

This book can be recommended to meet the requirements of students to obtain an elementary but a clear understanding of this vital subject so important to but still in its infancy in India.

A. N. RAO.

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TOADS AND TOAD LIFE. By Jean Rostand. Translated by Joan Fletcher. (Methuen & Co., Ltd., Essex Street, London, pp. xii+185, 1933.) Price 7*s*. 6*d*. net.

To the generality of people the common toad is a repulsive creature, but to the biologist it is perhaps one of the most fascinating objects of study and observation. The cobra and the toad are animals around which quite a volume of superstitious beliefs has grown few of which, however, are borne out by facts. The nocturnal and solitary habits of toads, their warty skin, ejection of urine on handling, large protruding eyes, their uncanny silence and sudden appearance and disappearance have all tended to invest these animals with an awesome character which is foreign to its nature and temperament. They have been curiously enough reared as pets by ladies who testify to their power of educability and good behaviour. The book is a tribute to the decent manners and romantic nature of toads which after all do greater service to mankind than most of its members.

The book provides an excellent and accurate account of the general habits of the toads with short but sufficient reference to the anatomy and development free from technical terms. The principal value of books of this type is to educate the popular mind, remove misconceptions and induce habits of sympathetic observation and collate them into some general order of scientific data. The book fulfils its object in an eminent degree. In the twenty chapters, into which the book is divided, the reader obtains a full and authoritative account of everything worth knowing about these obscure and puzzling batrachians. When we lay down the book after reading the last chapter, we feel that buried under a phlegmatic temperament, there is on the toads a great deal of energy and character and their service to man is capable of elevating them to membership of polite society.

The book is illustrated by every phase of toad life and is provided with bibliography. It has a great educational value in giving the reader a body of carefully arranged information and in stimulating his observation on other animals in his surroundings.

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REPORT ON BURMESE FISHES COLLECTED BY LT.-COL. R. W. BURTON FROM THE TRIBUTARY STREAMS OF THE MALI HKA RIVER OF THE MYITKYINA DISTRICT (Upper Burma). Parts I and II. By Dev Dev Mukerji. *Journ. Bomb. Nat. Hist. Soc.* Vol. XXXVI, pp. 812-831 (1933) and Vol. XXXVII, pp. 38-80, 3 pls. (1934).

The paper under review is one of the most detailed accounts of the Burmese fishes published within recent years. The account is based on a large collection of fish collected by Col. Burton at the instance of the Bombay Natural History Society. The collector believed that there are 80 species available in the area, but he obtained only 50. The material on careful analysis, however, showed that there were only 32 species in the collection and the author has dealt with the entire collection in great detail, giving a careful account with illustrations, where necessary, of the various species and elucidating several difficult problems of taxonomy and clearing up the synonyms of a large number of hitherto inadequately described or poorly known species.

The paper under review is one of most careful works on the fish fauna of any part of India published within recent years and it fills up an important gap in our

knowledge of the fishes of India. It is hoped that such studies on the fish faunas of other parts of India would be published by authors who are in a position to deal with the faunas of the different parts of the extensive continental area of India, as that alone will enable the compilation of a new edition of the "Fauna of British India" (Fishes) which is a great desideratum at the present day. The old "Fauna of British India" (in two volumes) by Dr. F. Day, published in 1889, is entirely out of date, and though useful as a work of reference, in view of the recent advances in our knowledge of the fish fauna of the world, is hardly acceptable as a standard publication.

B. P.

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THE SCIENTIFIC JOURNAL OF THE ROYAL COLLEGE OF SCIENCE. VOL. IV. (Edwin Arnold & Co., London, pp. 171, 1934.) Price 7*s*. 6*d*. net.

The Journal published in a book form contains seventeen papers read during the session 1933–34 before the Imperial College Chemical Society, the Royal College of Science Natural History Society Section and the Royal College of Science Mathematical Physical Society. The seventeen papers are distributed in the order of seven, six and four among the above institutions and they embrace a variety of interesting and important subjects.

The lectures on Gold, Aluminium and Vitamin D are of great interest and form an excellent document of readable matter. The other papers in the chemistry section such as those on the chemistry of Nitrogen and the structure of sesquiterpene group and water of crystallisation and shapes of molecules are technical and illuminating.

The paper on "the Distribution of *Salicornia Europea* at Ynyslas, Dovey Estuary" is the abstract of a student lecture and is a praiseworthy contribution to the Natural History Society. Professor C. D. Darlington's lecture on "Mechanical Aspects of Nuclear Division" sets forth the mechanical relationships of cell-physiology, genetics and evolution to the morphological study of nuclear division and of meiosis, and lines of immediate advance in research of quantitative studies of nuclear division are indicated. The lecture on "The Romance of Grass-land" is an exceedingly interesting exposition of the development of the present-day grass-lands from the forested lands of primeval times. There is an element of pathos in the spectacle of mighty trees being felled for milling purposes, and the grandeur of the primeval forest thereby destroyed, but there is romance in the process of grassland creation which begins when the agriculturist follows in the path of the timber-getter. An equally interesting paper is that on "The Purpose and Natural Selection, a Defence of Teleology."

In the Mathematical and Physical Science Section, the papers on "Foot Measurements for Shoemakers and Noise—Its Measurement and Abatement" are ingenious studies.

The fourth volume of the Journal maintains the high standard set up by the previous publications and they together constitute an excellent reference work.

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## Errata.

Vol. III, No. 1, p. 20, right-hand column, after line 31, *read* (Ushakov, *J. Russ. Phy. Chem. Soc.*, 1929, **61**, 795).

Page 19, left hand column, line 6, *for* System[1, 2] producing *read* System (I)[1, 2] producing.

Page 19, left hand column, footnotes *for* [6] Bühmann *read* [6] Billmann.

Pages 19 and 20, Formulæ I and VII

*for* $C=O$ *read* $C=O$ or $C=O$

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1350–34.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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CONTENTS.





# Indian Public School.

THE extracts from the report of the Indian Public School Committee, which have recently been published in the Press, are sufficiently full to enable the discerning public to form a fairly correct estimate of the value and significance of the institution proposed to be established early in the next year at Dehra Dun. Some of the important features of the recommendations of the Committee, which have all been accepted by the Government of India, are that the School, as was originally conceived by the late Mr. S. R. Das, is to be founded on the model of the English Public Schools; its first Head Master and the Assistant Masters are to be Englishmen possessing an intimate knowledge and experience of the work and organisation of English Public Schools; the aims and ideals of the Indian Public School will develop in an atmosphere of Indian culture and environment; the courses of study provided for the pupils will be sufficiently varied so as to offer scope for individual differentiation, and the social, religious and communal solidarity will be promoted by the genial influence of a common messmatism and comradeship in compulsory games. The School is proposed to be located in the buildings of the Imperial Forest College and Research Institution which together with the surrounding grounds have been acquired at a cost of three lakhs of rupees; and for the construction of additional structures and for endowment of funds the Committee have fourteen lakhs of rupees in their possession, which they hope to supplement from public benefactions. As a tentative measure residential accommodation has been provided in the main building for two sections with sixty boarders in each. The minimum and maximum ages of the first batch of scholars are fixed at eight and twelve years, which in the successive stages will be raised to twelve and nineteen, involving the gradual abolition of the lowest classes. The administration and general control of the School will be vested in a Board of Governors consisting of officials occupying exalted positions. Presumably the School is going to start on its career of usefulness under the most august and propitious circumstances.

The scheme is undoubtedly irreproachable. The ambitions of its promoters are truly praiseworthy.

The aims and objects of the School which

have been described in detail by the Committee appear to us, however, precisely identical with those about which we are daily accustomed to read in the addresses and speeches made on the ceremonial occasions of laying the Foundation Stone, or the annual prize-giving functions of primary and high schools in India. We are confident that no important pronouncement is made at these gatherings without a generous reference being also made to the schools developing "in an atmosphere of Indian culture and social environment" and that the outlook of the whole school should be distinctly moral and spiritual. Every convocation address is adorned by exhortations to the graduates on the importance of cultivating self-discipline, building up of a lovable character, developing the capacity for corporate action in civic life and fostering the spirit of chivalry and fairplay in normal human dealings. When School "days" are celebrated, the gentleman, "gracing the occasion with his distinguished presence," devotes his whole speech to extolling the quality of manliness and self-reliance and to persuading the young scholars to be free from the taint of social, communal and provincial prejudices and to cultivating the spirit of "united nationhood".

In the course of his scholastic career, a young pupil is destined to listen to such exhortations on at least 20 occasions and the need for them indicates that the unassisted efforts of education are inadequate to fortify his mind against the malign influences of the world which he is about to enter. While we admit theoretically that man is made in the image of God, we practically adopt the Jesuit doctrine that the young man harbours in his soul the author of evil, who is to be exercised by speeches and birches. The essence of education as we practise it is an elaborate attempt to convert the natural human animal into a conventional mechanised being, and every instrument which civilised society could invent is requisitioned for completing this process of metamorphosis. From the days of which we possess any historical record down to modern times, progressive education, apart from "illuminating the mind", has been a ceaseless struggle in the attempt to weave a rigidly uniform moral and spiritual garb for its votaries, and in this enterprise all the auxiliary forces of public opinion, the church and the state are enlisted. The fact that the report of the School Committees, the speeches addressed to youth in schools and colleges insist on the prescription of religious and moral instruction as an integral part of the educational programme must be a sorry commentary on the essence of human nature, which, at the least provocation, is apprehended like Arthur's Kingdom to reel back to the beast. The reason for this constant repetition of levitical doctrines in educational reports is due to our inadequate recognition of the law of change in the realm of objective reality and in the world of thought. The progress of science has altered our conception of the human mind and of the constitution of matter. The young men who are nurtured on the milk of the new philosophy inevitably subject all fundamental ideas to re-examination untrammelled by the "word of man", and they will not hesitate to go down to the very basis of things. We deliberately stimulate in the young men this spirit of unfettered enquiry in the sphere of intellect. Could we then curtail this newly discovered freedom from extending its influence into other domains? A conflict inevitably arises on the discovery that the progress of intellect has outstripped that of the other component parts of the mind, and modern education is confronted with this disjunction of intellectual and moral faculties. It is unable to equalise the pace of mind in the different fields of thought because of its adherence to an ancient code of conduct on the one hand, and on the other, its loyalty to freedom in the intellectual sphere. We are trying to put the heady wine of modern scientific knowledge into an old world ethical bottle; and the restlessness of the present age is the product of this attempt; and until the Church evolves a more satisfactory code of morality and a more rational system of spirituality, we shall have to continue to repeat the formulæ which form the staple of all educational reports and addresses.

The idea of an Indian Public School on the English model is not new; the various schools which commemorate the memories of Bishop Cotton, Baldwin and Lawrence are organised on the best traditions of the English public schools. They were originally intended for the benefit of children belonging to the domiciled Anglo-Indians, but more recently children of other communities also are admitted. We find in

them large numbers of day boys and resident scholars; the study and dormitory system; that unmitigated public nuisance of a personage, *viz.*, the monitor, prefect or preceptor; compulsory games; a staff of European Head Masters, Assistant Masters and Matrons; a delicately adjusted code of corporal chastisement; and finally, scout corps and military training including practice in pugilistic exercises. The Viceroy and the Provincial Governors, who are usually invited to preside at the ceremonial gatherings of these institutions, listen with great patience and interest to the reports of the Head Masters narrating the achievements of their pupils and in their replies, they pay glowing tributes to the excellent performance of the schools. The pupils are trained for public service in all its branches, for technical professions and for a military career; but few elect to proceed to higher education in the Universities. We have actually therefore a large number of Indian Public Schools in full action following the traditions of their English counterparts.

The English public school is certainly an elusive subject which "comprises in itself a difficult study of no inconsiderable magnitude," and within recent times the entire system has been criticised. The great head masters such as Dr. Butler, Arnold, Thring, Sanderson and Almond, who by their personal qualities built up great schools from small foundations, differed radically in everything that was essentially of educational importance. So different is the outlook of these schools that it is commonly said that "what are truisms at Rugby are paradoxes at Harrow, and an Eton custom would prove a Marlborough revelation." In spite of broad differences in the type, the English public schools occupy an important position as educational centres, and so great has been their influence on public life that even secondary schools and national schools are coming more and more to be run on public school lines. The European schools in India, which reflect the principal characteristics of the British system and which have been in existence for a long time, have not attained the reputation and influence on the public life which the English public schools possess. This is due not so much to their exclusiveness and want of adequate financial support as to the preferential treatment of these schools. The English public schools, on the other hand, owe their eminence to the surpassing fame of the head masters, distinguished alike by their scholarship, piety and public zeal. Their devotion to an ideal altered the face of education all through the public schools in England in a manner which neither government grants nor even popular support could have produced. They organised their own machinery, evolved their own principles of administration and invented their own methods of teaching, to each of which they imparted touches of their personal character.

We have heard a great deal about the criticisms on the games, punishments, the monitorial system and the exclusive spirit of the English public schools; but in the long course of their existence, some aspects of the school activities are apt to receive greater emphasis. Judged, however, from the widest point of view the English public schools are an invaluable heritage of the British people. Their pupils adorn their calling with their own particular aptitudes and knowledge, their own qualities of willingness to accept responsibilities and their ability to set an example wherever their lot may be cast. It is perfectly legitimate for the leaders of Indian public life to desire to found an institution in India turning out a band of brave, helpful and chivalrous Indians ready to shoulder cheerfully responsibilities and to regard service as its own reward.

Does the projected Indian public school possess the seeds which will germinate its greatness? It seems to us that while government support and supervision are an asset to all educational institutions, its inspiration and practical guidance may hamper the growth of the schools. None of the great public schools in England, none of the great scientific institutions, none of the universities owe their origin to government initiation. It is men with a missionary zeal for an ideal that create public institutions, to whom worldly goods and recognition are entirely of subordinate consideration. The Indian Public School is proposed to be brought into existence under slightly different auspices. The catalogue of aims and objects intended to be achieved by the Indian Public School is not its monopoly, and perhaps represents the pious wishes of its promoters. We are told that the School is to develop in an atmosphere of Indian culture and environment, but the conditions created for its management seem almost hostile to the realisation of this object. A number of

European teachers surrounded by children between the ages of eight and twelve, separated by language barriers and ignorance of each other's mental presuppositions, is suggestive of the tower of Babel rather than a seminary for fostering culture. Moreover, Indian culture and environment cannot successfully be hoped to be cultivated through optional studies of Indian vernaculars and classics, and an Englishman fresh from England,—if he is a reasonably humble and wise person—will refuse to be their exponent.

The moral and spiritual development of the school children is to receive the special attention of the masters; while it is fairly easy to grasp the exact connotation of the former term, the latter is a trifle puzzling. It seems to us that the work of the pupils in the class-room and their extramural activities should be founded on a moral basis rather than that we place before the immature minds, a code of illusive doctrines. The moral sense has to grow as an integral part of the development of the intellect and no teacher, however eminent, can hope to accomplish this seemingly impossible task unless he is thoroughly conversant with the racial history, family traditions and the mental make-up of the children. It is almost impossible to achieve spiritual unity in a heterogeneous assemblage of pupils, who follow different persuasions, and if by spirituality we mean God-mindedness and not what pertains to religion, perhaps schools might attempt to produce it without ecclesiastical assistance. The Indian Public School is proposing to achieve what the government and aided institutions have tried, and are silent about the fruits of their labours. Are we justified in investing nearly 20 lakhs of rupees with further financial implications, on an institution whose ostensible object is to turn out 50 or more young men annually, who will be moral, spiritual, chivalrous with a capacity for corporate actions and for military, professional and university training? Cannot the same results be obtained by re-organising and consolidating a few of the selected European schools in India where the traditions of the English public schools are reproduced? The success of the Indian Public School and the establishment of its reputation as an educational centre are not financial and pedagogical problems; they are, however, assured if the European officers in India consent to send their children to this institution to be trained along with Indian children. Their interest in the institution would then become personal, instead of remaining academic. We can conceive of only one justification for bringing so costly an institution into existence. The Indian child is a biological organism,—not of the variety of Strasburg goose;—and is to be trained to acquire a view of the world in perspective and to realise that what he does or thinks is not the product of one community or one country and that he himself is the citizen of the world as a whole. The morality and spirituality that the Indian child—like every other child,—has to learn in the Indian Public School ought to consist in the paramount duty to join the rest of the world in a spirit of co-operation to improve the lot of his fellow-men irrespective of territorial, racial and language barriers. If the Indian Public School succeeds in producing this frame of mind in its pupils, it will be the only justification for its continued existence and public support.

# Survey of Commercial Indian Cottons.

By R. D. Mihra, M.A., B.Litt. (Oxon.),
*Publicity Officer, Indian Central Cotton Committee, Bombay.*

A BOTANICAL survey of Indian cottons must necessarily cover an extraordinarily cumbersome range of types some of which are of scarcely enough importance as commercial commodities. Nevertheless what is left of the more important types which dominate the economy of the country's cotton industry embraces perhaps one of the most divergent ensemble of types to be found in any single important cotton-producing country of the world. Climate, soil and other natural dispensations which govern the organic susceptibilities of the flora of this country vary, sometimes at sharp angles, from region to region, and it is not at all surprising that cotton culture ramified throughout the length and breadth of the country, sometimes in sporadic, discontinuous patches and sometimes with immense continuity of range, should present such a complex variety of types and economic values.

GEOGRAPHICAL DISTRIBUTION OF TYPES.

In attempting a botanical survey, I shall confine myself, for the present, to such of the types of cotton grown in India as are of proved economic value, either in the light of present conditions or of the prospects which a decade of outstanding research has already ushered in.

The general name given to the cottons grown on the Indo-Gangetic plain is "Bengals", the chief sub-classes under this group being "Sind-deshi", "Punjab-deshi", "Rajputanas" and "United Provinces".

The "Oomras" occupy large areas of the Central Provinces, Central India, Berar, Khandesh, Nasik and the Nizam's Dominions. The "Oomras", however, comprise nearly half a dozen sub-types variously distributed in the above-mentioned areas. The "Broach" and "Dhollera" varieties are grown largely in Gujerat, the latter chiefly in the north and extending to Kathiawar. The "Kumptas", "Westerns" and "Northerns" largely occupy adjacent areas, the first, in southern part of the Bombay Presidency and the last two extending away to the east, occupying the northern part of the Madras Presidency and the southern part of the Nizam's Dominions. "Dharwar-American" and "Gadag No. 1"—the former an upshot of efforts to introduce American cotton—are grown almost exclusively in the Dharwar District. "Punjab-American", also an acclimatised upland American cotton, occupies nearly a million acres in the Canal Colonies of the Punjab. "Tinnevellys"—a mixture of two distinct types—"Karunganni" and "Uppam"—is grown in about 600,000 acres in the districts of Madura, Ramnad and Tinnevelly, but is gradually giving place to pure "Karunganni". "Cambodia"—a type of American Upland flourishing throughout the southern cotton-growing tracts of the Madras Presidency—is found chiefly in the district of Coimbatore (Tiruppur) and in the western part of the district of Madura. It occupies nearly 350,000 acres.

"Comilla" which derives its name from a town in Assam is almost exclusively confined to Eastern Bengal and Assam.

CHARACTERISTICS OF TYPES.

"Bengals" form, on the whole, the shortest staple cotton in India. They almost always consist of a mixture of various varieties of *Gossypium neglectum* with a variable percentage of *Gossypium indicum.* The staple length of "True Bengals" varies from 4/8 to 5/8 inch and in the case of "Ordinary Bengals" from 3/8 to 4/8 inch. They are coarse but usually of good colour. "Sind" and "Punjab-deshi" contain nearly the same varieties and possess staple of nearly the same length. The "deshi" variety in the Punjab contains almost everywhere at least 4 different types.

The "Oomras" comprise five distinct varieties known as (1) "Bani" or "Gaorani", (2) "Berar cotton" composed of a mixture of varieties of *Gossypium neglectum,* (3) "Central Provinces cotton", (4) "Khandesh" and (5) "Central India cottons". "Bani" consists essentially of *Gossypium indicum* with a ginning percentage of 25 and has a low acreage yield. Of indigenous Indian cottons, it is the finest with a staple length of over 1 inch. "Berar cotton" has a staple length varying from 5/8 to 6/8 inch with a certain amount of *Gossypium indicum.* The "Central Provinces cottons" consist of a mixture of different varieties of *Gossypium neglectum* with a certain amount of "Bani". The ginning percentage of "Khandesh" variety varies

from 33 to 38 and its staple length is nearly 1/8 of an inch less than that of "Berar cotton".

"Central India cottons" vary in quality from "Khandesh" to a type approaching the best "Central Provinces cotton". One of its varieties known as "Malwa" consisting entirely of the best type of *G. neglectum* has a staple length of from 6/8 to 7/8 inch, though a somewhat low ginning percentage.

"Broach cotton" consists of a mixture of varieties of *Gossypium herbaceum* the best of its types reaching a staple length of 7/8 to 1 inch, though, further north of Navsari, the quality tends to get lower. Its ginning percentage varies from 30 to 32.

The standard types of "Dholleras" locally known as "Wagad" and "Lalio" consist of *Gossypium herbaceum* and have a staple length varying from 5/8 to 7/8 inch and a ginning percentage of 33.

The "Westerns" and "Northerns" closely resemble the "Kumptas" and are composed of a mixture of varieties of *Gossypium herbaceum* and a variable proportion of *G. indicum* with a staple of from 6/8 to 7/8 inch.

The "Dharwar-American" a mixture of Upland American (*G. hirsutum*) and New Orleans (*G. mexicanum*) is an acclimatised type slightly inferior in staple to "Kumpta" but with a ginning percentage of 30 and not nearly so leafy.

The "Punjab-American" is also an acclimatised Upland American, with a colour and style very closely resembling ordinary Upland American. The ginning percentage is about 32. This cotton has a tendency to poor response in the absence of adequate irrigation in length and strength. Its staple length is about 0·9 inch.

"Tinnevelly" is a mixture of "Karunganni" a variety of *G. indicum* and "Uppam" (*G. herbaceum*). It is a dry land crop and flourishes on black soil of varying depth and natural fertility. Its staple length varies from 6/8 to 7/8 inch and it has a ginning percentage of 27, has a slight creamy colour, and is strong. It is sown in October-November and is harvested between March and August.

"Karunganni" a variety of *G. indicum* is white in colour with a ginning percentage of 25 to 26, and a staple length of 9/10 to 1 inch. Tests have definitely established its superiority over "Uppam" both in point of staple and outturn.

"Cambodia" flourishes in light red soils irrigated from wells and belongs to the Upland American variety (*G. hirsutum*). It is sown in September-October and harvested from April to May, allowing for a second picking 2 months later.

"Comilla" (*G. cernuum*) with a sub-variety (*G. cernuum sylhetense*) of khaki coloured lint, is distinguished for the size of its bolls which sometimes attain a length of nearly 8 inches. Its staple is short, about only 3/8 to 4/8 inch, ginning percentage varying from 43 to 50. Its lint is very harsh in feel and the cotton is therefore used as an adulterant with wool.

## Zesde Internationaal Botanisch Congres, Amsterdam, 1935.

THE Sixth International Botanical Congress will be held at Amsterdam from 2nd to 7th September 1935. An influential organising Committee with Prof. F. A. F. G. Went as President and Dr. M. J. Sirks as Secretary has been formed to work out the details of the programme. It may be mentioned in this connection that the Fifth Congress was held at Cambridge in 1930 when Prof. A. C. Steward was the General President and the proceedings of the Congress have been published as the "Report of Proceedings" which form an important addition to the Botanical literature of the World.

Dr. Birbal Sahni, D.Sc., Sc.D., F.G.S., F.A.S.B., Professor of Botany, University of Lucknow, has been invited to accept the Vice-Presidentship of the Section of Palæobotany. Prof. Sahni was appointed to the same post in the last Congress held at Cambridge when the late Dr. D. H. Scott was the President of the Section of Palæobotany. The Professor enjoys an international reputation, and the distinction conferred on him a second time will give general satisfaction to scientists throughout the country. In offering Prof. Sahni our warmest felicitations, we venture to hope that at the next Congress he will be invited to occupy the Presidential Chair.

# The Indian Mango.

By Dr. P. Maheshwari,
*Agra College, Agra.*

THE original home of the mango is not known with certainty, but it has long been one of the most familiar trees about villages in India. There are many orchards of the finer varieties and the fruit is greatly praised. Many roads are lined with stately trees, giving a welcome shade during the hot season, as the tree is evergreen.

The different varieties of *Mangifera indica* L. produce flowers at slightly different times and blooming is somewhat earlier in the southern part of the peninsula than in the north. In the United Provinces of Agra and Oudh the height of blooming is in February and early March. The flowers are borne in large pyramidal profusely branched panicles with the ultimate branchlets cymose. The number of flowers in each inflorescence may vary from 1,500 to 4,000, and the varieties with better fruit seem to have the largest inflorescences.

The flower usually consists of 5 sepals, 5 petals, 5 stamens and a single carpel. There is some variation in the number of stamens and occasionally a flower may show primordia of all ten stamens—a rather common thing in other members of the family. Characteristically, however, only one stamen develops and the other four remain abortive. The ovary contains a single anatropous ovule. The style arises from the edge of the slightly compressed ovary. The fertile stamen is on the opposite side of the flower and is of the same diameter as the style. Rarely 2 carpels and less rarely 2 fertile stamens may develop.

In spite of the large number of flowers produced in a single inflorescence, it is well known that ordinary village trees produce on an average only 2-3 fruits per inflorescence and even the best varieties do not commonly have more than half a dozen. Most of the flowers dry up soon after blooming and fall off. A study of microtome sections reveals the fact that these have an abortive ovary and can function only as pollen-producers. Perhaps only 5-10% of the flowers that open have normal-looking ovaries. After a slight enlargement most of the ovaries turn yellowish, shrivel up, and the entire flower drops off. Of the few that remain, most drop off at the size of a small pea. The very few that survive this period usually continue to develop further. The flowers with normal-looking ovaries occur mostly towards the apex of the inflorescence and are mainly the primary flowers of the little cymes and to a less extent the secondaries; a tertiary flower of the cymelet almost never produces a good ovary. Later appearing tertiaries and quaternaries are likely to fall off while they are still small buds.

Besides the high mortality of the flowers, it is also a matter of common experience that while fruits are produced in fairly large quantities one year, there is a great paucity of them in the next. In North India mangoes were very cheap in 1933, but in the 1934 season the mango crop has been an almost complete failure. This kind of alternate fruiting is, however, also found in several other fruit trees, though perhaps not so well marked as in the mango.

An account of the floral morphology of the Philippine varieties of the mango has recently been given by Juliano and Cuevas.* The present study† which was started more than 10 years ago confirms their observations in a general way, but there are a few differences which are sufficiently noteworthy to be mentioned here. Some other points not mentioned by these authors are also dealt with briefly.

*The Anther.*—The development of the anther follows the usual course laid down for angiosperms, except that the sporogenous tissue is rather late in differentiating and is clearly distinguishable only after the walls are practically completed. There is an epidermis, endothecium, two middle layers and tapetum enclosing the mass of sporogenous cells within. At about the time of the first meiosis, the tapetal nuclei divide and the cells become binucleate. The reduction divisions in the microspore mother cells seem to go through in a normal way. The nuclear cavity is about 10 microns in diameter at the time of the greatest enlargement and

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* *Philippine Agriculturist*, 1932, **21**, 449-472.

† My teacher, the late Dr. Winfield Dudgeon of Allahabad, had started some work on the morphology of the mango in the year 1920. For various reasons this could not be brought to a finish, and after his unexpected death on December 26, 1932, all his slides and rough notes were forwarded to me by Mrs. Dudgeon with a request to complete the work.

the chromosome pairs at diakinesis are so small and so closely applied to the nuclear membrane and clumped together amongst themselves that exact counting became impossible. There are, however, approximately 26 (24-28) pairs of chromosomes. Wall formation is simultaneous and comes on after the second reduction division is completed.

The development of the male gametophyte follows the usual course. A minute lenticular generative cell is cut off at one end of the pollen grain, but it soon moves inward and divides to form 2 male nuclei. Here my observations differ from those of Juliano and Cuevas (1932) who report that the pollen grains are uninucleate at the time of shedding. This appears to me to be very doubtful. The real fact is that there are widespread degenerations in the anther at this stage and even in those pollen grains which develop further there is so much starch that the nuclei become obscured in a great majority of the cases.

*The Carpel.*—Comparable with the anther, the archesporil cell is so inconspicuous in the nucellus that it cannot be distinguished with certainty. Only after the wall cell has been cut off and has divided once or twice, is the megaspore mother cell enough larger than the surrounding cells to be identified distinctly. The wall cells soon undergo many divisions so that the megaspore mother cell becomes deeply placed in the nucellus.

So many of the mother cells degenerate that it was not possible for me to have a sufficiently close series of stages for the study of the development of the embryo sac. But from what I have seen of the few good preparations I possess, I have no doubt that the development proceeds in the normal way as reported by Juliano and Cuevas. The mature embryo sac has an egg, two synergids, three antipodal cells and two polar nuclei which fuse early. The fusion nucleus lies almost in contact with the egg.

*Pollination and Fertilisation.*—The flowers open in the afternoon and remain fresh looking till next day. Then the sepals and petals become reflexed, gradually wither and drop off. Pollination seems to be in sufficient, for the stigma is poorly developed and there is a large percentage of defective pollen. Insects, specially flies, visit the flowers, but pollination through gravity and wind is not excluded. As the air is dry enough pollen can merely drop on from the higher inflorescences to the lower.

Actual fertilisation has not been seen, but in several embryo sacs in which endosperm formation had begun, I could see a small nucleus lying close to the egg nucleus and in slightly later stages 2 nucleoli in the nucleus of the zygote.

*Endosperm and Embryo.*—The primary endosperm nucleus seems to divide at once after fertilisation. Free nuclear division continues and a peripheral layer of endosperm nuclei is formed in the rapidly enlarging embryo sac. The embryo shows a remarkable delay in development. There are evidences that, occasionally, the fusion nucleus may be fertilised but not the egg. This seems to explain the statement of Juliano and Cuevas that "Some pistils have been observed to enlarge without any seed within."

The first division of the zygote occurs very late. An ovule with a 3-celled embryo had over 950 endosperm nuclei—a record for delayed development of the embryo in angiosperms, so far as I know.

Further stages have not yet been observed and a fuller account will be published as soon as sufficient material has accumulated.

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## The British Polar Year Expedition to Fort Rae, N. W. Canada, 1932-33.

MR. J. M. STAGG, in a paper presented at the Aberdeen meeting of the British Association for the Advancement of Science, dealt with some results of the "intensive observations in Meteorology and such allied fields of investigation as terrestrial magnetism, aurora and atmospheric electricity." Upwards of forty countries co-operated in the world-wide organisation and probably "over sixty special stations and expeditions, many of them in high northern latitudes, participated in the general programme. An expedition of six men was sent by Britain to reoccupy the station at Fort Rae on the Great Slave Lake, N. W. Canada. "The reduction of the data brought home by the expedition is now in an advanced stage of preparation. But the work of adequate discussion and co-ordination with the data for all the other Polar Year Stations, will be a matter of several years."

# Obituary.

## Dr. C. A. Barber, C.I.E. (1860-1933).

WITH the passing away of Dr. Charles Alfred Barber in the February of 1933, the scientific world in general and the pioneers of scientific agriculture in India in particular, sustained an irreparable loss.

Born at Wynberg in South Africa in November 1860, he came to England in 1871 and received his early education at Bath. In his 18th year he took service in a bank at Liverpool; but the love of nature, which he had acquired in his early South African home, urged him on to science, with the result that in 1883 he went over to Germany where he came under the personal influence of such eminent botanists as Strasburger, Schmitz and Schimper. In his 24th year he returned to England getting himself definitely wedded to botany and was admitted as a scholar in Christ's College. He was appointed Superintendent of Agriculture in the Leeward Islands in 1891, but had to return to England in 1895 owing to the abolition of his post. It was in these Islands that he made his first acquaintance with the plant to which he was destined to devote the last and perhaps the most fruitful years of his valuable life—sugarcane.

Dr. Barber came out to India in 1898 to take up the dual appointment of Government Botanist, Madras, and Director of the Botanical Survey of South India on a five-year basis. During this period he did the pioneer work of exploring the heavy forests of the Presidency, where the black monkey was sometimes his sole food. The collections made resulted in a number of plants being named after him. It was during this period that he carried out an extensive series of investigations on the *haustoria* of the sandal and other plants which obtained for him the degree of Doctor of Science (Cambridge).

But work of an economic nature was soon to occupy his attention. In 1899 the Government of Madras was faced with a steadily shrinking area under sugarcanes in the Godavery delta on account of the prevalence of 'Serah' and Dr. Barber was put on to it. He replaced the canes in cultivation with disease-resistant varieties with the result that the area began to recover. These were days when the then Government Botanist of Madras represented a good bit of the activities of a department which was just then kicking itself into life—the Agricultural Department. These belonged to the pre-Curzon period when there was no properly organised Agricultural Department in the country.

Besides sugarcane, diseases of both pepper and groundnut came under his purview with the result that his work included that of both mycologist and entomologist. Along with the late Mr. Benson he was responsible for the selection of site of the present Agricultural College at Coimbatore and also for the design and equipment of the various laboratories at the Coimbatore Institute with the exception of those devoted to chemistry. Returning to Coimbatore in 1908 after a couple of years' furlough in England, he organised the teaching courses in botany at the Coimbatore Agricultural College and started preliminary work on the breeding of various crops such as cotton, gogu and groundnuts, largely with the idea of building up material for the teaching at the College.

When, as a result of the powerful advocacy of the then Hon'ble Pandit Madan Mohan Malaviya before the pre-reform Central Legislature of those days, the Central Government decided to found a Sugarcane Breeding Station for all India, the subject of our sketch, who was admirably suited for the post by his previous work both in the Leeward Islands and in the Madras Presidency, was naturally selected.

From the year 1912 to 1919 he held the post of Government Sugarcane Expert for all India but with headquarters at Coimbatore. He soon applied himself to the task with his usual energy and thoroughness with the result that the Indian canes got themselves grouped for the first time on a proper scientific basis. The fact that his classification, based on external morphological characters, has been largely confirmed by the later and more recently developed chromosome investigations of Dr. Bremer, bears testimony to Dr. Barber's skill and judgment both as Systematist and Morphologist. His keen systematic mind made him start a collection of the wild types of *Saccharum* at Coimbatore and he was the first to deliberately use *Saccharum spontaneum* for crossing with sugarcane. Coimbatore canes are now occupying over 50 per

cent. of the Indian cane area and are steadily winning for themselves considerable reputation in other countries as well, and Dr. Barber was the founder of a station which has brought forth such good results in the fullness of time. Government conferred on him the title of C.I.E. in 1918 and his contribution to Indian Agriculture was fittingly recognised by the award to him in 1931 of the first Maynard-Ganga Ram Prize. When he returned home in 1919 he did so loaded with honours and respected by his colleagues both at Coimbatore and in other parts of India.

No sketch of his life would be complete without a reference to his methods of work. He was accurate, thorough to minute details and systematic almost to a fault. Everything in and about him was orderly. It was this that enabled him to get through an enormous amount of work with what looked almost like ease. He was a good and swift writer, very guarded in his expressions, an expert photographer and an artist of a high order, his holidaying often consisting of painting pictures. He was an all-round athlete and one was surprised to see his play at the tennis court even after he had put 55 years of strenuous life behind him.

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## Madame Curie (1867-1934).

THE death of Madame Curie which took place in a hill sanatorium on July 4, has deprived the scientific world of a great investigator and her family of a loving relative. Her death was the result of a short illness which seems to have been due to constant exposures to radiations from radio-active bodies with which her whole life-work was connected. Madame Curie was for the last few years engaged in preparing a more powerful source of actinium: she has thus died in full harness, but leaves a capable daughter and son-in-law to carry on the good work. Her remains were interred at Sceaux by the side of her beloved husband in accordance with her last wishes.

Madame Curie was Polish by birth and her maiden name was Marie Sklodowska. She was born at Warsaw on the 7th of November 1867 and received her early education in that city. Her love of science was so strong that in spite of straitened finances she determined to complete her education at Paris. Here she entered as a student at the Sorbonne and came under the influence of M. Pierre Curie who was one of her Professors. The common interest of master and pupil in scientific discovery ripened into a closer sentiment and Marie Sklodowska became Madame Curie in 1895. Madame Curie was not only the helpmate of her husband in domestic affairs but shared his scientific work to such a degree that M. Curie was most anxious later on to give all the credit of their joint discoveries to his wife.

It is now a matter of history and common knowledge how she became interested in Becquerel's discovery of radio-activity in 1896 and assumed the dominating place in this science by her discovery of Polonium and later by the isolation of radium. When it is recalled that a ton of pitchblende yields a few milligrams of radium and that the separating of this small quantity of the precious element from the large mass of mineral was done mostly by Mme. Curie who was responsible for the chemical part of the joint investigations, we can appreciate the patience and love of pure investigation which contributed to her just fame.

The work was done under very unfavourable conditions in a building in their backyard and mountains of pitchblende were piled up in all the available space. All the extraordinary pains taken fructified when the discovery of radium brought her honours from the entire learned world. Even here she had to contend against the disabilities of her sex; people expected her to remain in the background and enjoy the honours due to her work through her husband. But M. Curie was insistent that she should be recognised through her own individuality and brought her to London in 1903 when he was requested to deliver a lecture before the Royal Institution on their new discovery. She was an applicant for a place in the Academy of Sciences at Paris some twenty years ago, and received an unusually large number of votes; yet dissent was expressed against the principle of admitting women and she did not find a place in that august body. She was so sensitive and modest that she did not renew her application when a change in the public outlook was sure to secure her admission. There was no lack of honours, however; she is the unique example of a person receiving the Nobel Prize twice—once for Physics in 1904 with Becquerel and M. Curie and again for

Chemistry in 1911. Other honours, too numerous to mention, were showered upon her. She was the first woman to become a Professor at the Sorbonne. She became the Director of the Radium Institute and continued till her death to direct a large mass of important original work. Her heart must have expanded with pride when her daughter Iréne Curie-Joliot repeated her own history as it were, and with her husband M. Joliot discovered the neutron and induced Radio-activity. In 1921 she visited the United States and received a gram of radium as a suitable present.

The importance of her discovery was such that it originated new branches of investigation in more than one department of science. Her discoveries were fundamentally responsible for the new developments in Physics and Chemistry; but a larger section of humanity will bless her for the benefit conferred by radium therapy. She volunteered during the War to place herself at the disposal of the Red Cross Society and personally superintended the radiological cars amidst the fighting armies.

Madame Curie.

She has done notable service to her native country, Poland, and to her adopted country, France and has served on numerous committees and commissions. The reconstruction of Poland after the War was a source of gratification to her. She was associated with H. A. Lorentz, Paul Painlevè and Albert Einstein in the International Committee of Intellectual Co-operation of the League of Nations, and interested

herself chiefly in the problems of the future of the human race—mass education and co-ordination of international scientific research.

In spite of the enviable position she occupied in the esteem of the world, she retained her serenity and simplicity to the last. The unfortunate death of her beloved husband M. Curie by a street accident in 1906 dealt her a blow from which she never perfectly recovered. Her noble and affectionate nature endeared her to all her friends. All those who came in contact with her were struck by the simplicity of her character and the penetrating quickness of her intellect. She will ever be remembered as one who by her personal example and eminence secured to womenkind a recognition of equality with men in all departments of life including scientific research. The present position of women is founded on the secure foundation of the greatness of such personalities as Madame Curie.

* * *

## Dr. S. K. Mukerji, F.L.S. (1896-1934).

DR. SUSHIL KUMAR MUKERJI, F.L.S., Reader in Botany at the University of Lucknow, Honorary Secretary of the Indian Botanical Society, died at Lucknow on the 5th August 1934, after a brief illness following an operation for appendicitis. He was only in his thirty-ninth year at the time of his death. About the middle of July he returned from Calcutta with a pain in the abdomen which had persisted for several weeks. On the 30th July he underwent an operation but by then he had already contracted peritonitis, which was followed by serious complications. The end came within a week, although for several days he had shown a steady improvement, making a brave fight against heavy odds. This remarkable power of resistance and of physical and mental endurance was truly characteristic of the man. He was endowed with an iron constitution, indomitable courage and a fervent spiritual faith of which few but his intimate friends were aware.

Sushil was born at Nowgong in Central India in March 1896, the second son of B. Kali Taran Mukerji, who survives him. He lost his mother when he was in his early twenties. His grand-father, Chandrakanta Mukerji, was Dewan and Foreign Minister of Bijavar State. S. K. Mukerji received his early education at Allahabad. He took the degree of B.Sc. from Muir College in 1916, migrating to Lucknow for a post-graduate course in Botany at Canning College, where he took a master's degree in 1920. In 1918 he was appointed a demonstrator in biology at that college, then affiliated to the old University of Allahabad. In July 1921 when the residential University of Lucknow was inaugurated and the college passed under a new jurisdiction, he was appointed University demonstrator in Botany. From this position, during the few years that were left to him, he had forged for himself a career remarkable for its many-sided success.

In December 1921 he was promoted to a Lecturer's post, and in December 1927 he was appointed Reader. This was immediately after his return home from a couple of years' study leave in Europe.

It was during this visit abroad that Mukerji found perhaps his best opportunities for exercising his versatile and dynamic personality. While preparing, for his doctor's degree in London, a thesis which was approved in November 1927, he found time for varied activities of an academic and social character. As a research student at University College, he gave valued assistance to the organising committee for the Centenary Celebrations of the College held in 1927. He read original papers and gave popular lectures on this occasion (**9, 10**)* as well as before the Linnean Society (1926 and 1927, **6, 7, 12**) of which he had become a Fellow; before the British Ecological Society (Manchester, 1926, **5**) which he had joined as a member; and before the British Association (Leeds meeting, 1927, **11**) for which he was elected a member of the sectional committee for Botany and Forestry. The esteem in which he was held was marked in a graceful manner by the presentation to him, by the staff of University College, of a barograph on the eve of his departure from London.

Mukerji returned to Lucknow in December 1927 after tour of the Continent, full of enthusiasm for the future. As before he threw himself heart and soul into anything that he took up, whether it was botanical research or gardening, sport and travel, the University Training Corps, the olympic games, or advisory work on the committees and councils of the University, of the Provincial Government, of the Indian

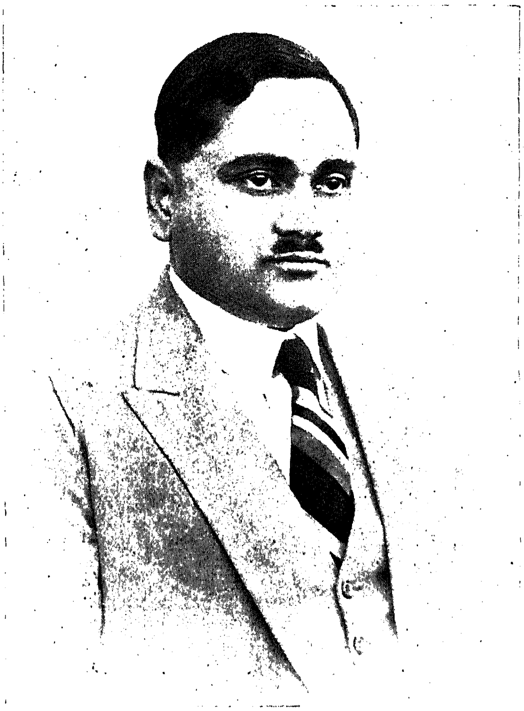
* These numbers refer to the list given at the end.

Science Congress, of clubs and societies. His enthusiasm was contagious. He was like a live wire running through all the organisations in which he had a part.

A man of extraordinary energy and driving force, he possessed a degree of self-confidence which the achievements of his brief career amply justified. But in a sense he was also the victim of his own versatility; too many of his scientific papers, although of great value as original contributions, were never followed up to the stage of full publication. The result was that he was robbed of his due recognition as a scientist, and Indian Botany of much of the fruit of his labours. Nevertheless, there can be no doubt of his great ability as an ecologist and taxonomic botanist, as a teacher and as an organiser.

Shortly before his death, the Executive Council of Lucknow University had appointed him a delegate to the International Congress of Soil Science, to be held at Oxford in the summer of 1935, under the auspices of the International Society of Soil Science. The soil relations of plants had become his favourite subject of research (**14, 15**) ever since his initiation at the hands of F. W. Oliver and E. J. Salisbury. His thesis for the London D.Sc. (**13**) which is now being published in the *Journal of Ecology* contains material of great interest concerning the autecology and distribution of *Mercurialis perennis*. Among other results, it showed the great importance of the hydrogen-ion-concentration of the soil as a factor in the growth and distribution of plants.

Latterly he had turned his attention to the causes of the high mortality observed among seedlings in nature (**24**). This is a subject of obvious importance in relation to the survival, the distribution and ultimately of the evolution of species during the natural struggle for existence. Here, again, he found that the soil factors, such as the carbonate content, water content, organic content and hydrogen-ion-concentration, exercise a decisive influence.



Dr. S. K. Mukerji, F.L.S.

The ecology of fresh-water vegetation was a pet subject with Mukerji and one to which he frequently returned (**5, 17, 19, 20, 21**) after his first paper, read before the Calcutta Session of the Indian Science Congress (1921, **2**), on the biotic succession in the flora of the Dal Lake in Kashmir. He had also made detailed studies of the floristics and ecology of parts of the Satpura range (**3**), of the Vindhya mountains (**4**) and of Lucknow and its vicinity (**1**). He was a taxonomist of considerable experience. His knowledge of the flora of Lucknow and its environs was unrivalled. Latterly he was engaged preparing an illustrated local flora. Such a work would have been of the greatest value to students, specially in the United Provinces. The figures for Mukerji's projected work had been prepared several years ago but so far as I am aware, the text had not yet been written.

From numerous excursions in the valley and among the mountains of Kashmir, Mukerji had gained an extensive knowledge of the Kashmir flora (**17, 19**), especially of the Lacustrine vegetation of the Dal and the Manasbal. A few years ago the Yale University expedition to the Karakorum range led by the German geologist Hellmut de Terra, had made an important collection of fossil plants in the so-called Karewa beds of Kashmir. These strata (of which the surface layers are a favourite soil for the cultivation of saffron) are commonly regarded as representing the sediments laid down in an extensive lake which must have

covered nearly the whole valley during the glacial age, and of which the Wular, the Manasbal, the Dal and other modern lakes are the dwindling remnants. Dr. de Terra wrote to me asking whether I could suggest the name of an Indian botanist who could undertake the investigation of this valuable collection: he would have to be a taxonomist familiar with the modern flora of Kashmir, but at the same time capable of appreciating the problem from the viewpoint of the distribution of species as affected by climatic fluctuations during the geologically recent past. The problem could not have been entrusted to abler hands than those of my late colleague. His name was suggested. Dr. de Terra readily agreed. It was with this problem in hand that Mukerji had made special visits to Kashmir and to Calcutta during the last two years. Shortly before his illness he was spending a vacation in Calcutta, comparing the fossil leaves, fruits, etc., with those of modern species from Kashmir, preserved in the herbarium at the Royal Botanic Garden. From the notes he has left, it appears that he had made provisional identifications of most of the fossils as far as they seemed comparable with living species. But, alas, the work was cut short in this preliminary stage: it remains one of the unfinished monuments of a life of unusually varied activity.

Lastly, mention should also be made of Mukerji's interest in Indian medicinal plants (**16, 18**) and on forest utilisation (**11, 22**): subjects on which he had sound views, based upon study and experience gained during his travels in Kashmir,—that region of intense scientific interest, destined only to be explored and appreciated by sons of foreign soil.

The void that has been left at the University, of which he was such an active member for the last thirteen years, will be difficult to fill. He will be missed on many occasions, and by many who had learnt to respect him as a fellow-student, a colleague, a teacher, a sportsman, as a friend and even as an adversary. A born fighter, with a keen sense of justice, he was quickly roused to a temper whenever he suspected unfairness; and regardless of himself, he would champion a cause solely from a passion for fair play. His best friends had nicknamed him 'Mussolini', an epithet not altogether belied by his appearance when confronted in argument. But those who did not see eye to eye with him will be the first to admit that in the end he was always open to reason, and that his assertive temperament concealed a generous heart.

Such was the man whom we mourn to-day, snatched away in the prime of life from a career of high utility but of still higher promise in the service of science and society.

B. SAHNI.

### LIST OF SCIENTIFIC PUBLICATIONS.

*Dr. S. K. Mukerji:* (1) A study of the floristics and ecology of Lucknow (*Proc. Indian Science Congress*, Calcutta, 1921, p. 185). (2) The Dal Lake (Kashmir): a study in biotic succession (*Proc. Indian Science Congress*, Calcutta, 1921, pp. 185-187). (3) Plant succession in the Satpura Range, near Pachmarhi, C.P. (*Proc. Indian Botanical Society*, **3**, 262). (4) Ecological studies of the vegetation of the Vindhyas (*Proc. Indian Botanical Society*, Lucknow, 1923; *Journal of the Indian Botanical Society*, **3**, 262). (5) The vegetation of the Dal Lake region of Kashmir (*Proc. British Ecological Society*, Manchester, June 1926). (6) The vegetation of Kashmir, a contribution to the ecology of the Kashmir Himalayas (*Proc. Linnean Society of London*, May 1926). (7) Geographical distribution of the genus *Mercurialis* (*Proc. Linnean Society of London*, October 1926). (8) A new variety of *Mercurialis perennis* in the British Flora (*Journal of Botany*, London, February 1927). (9) Habitat forms of *Mercurialis perennis* (*Proc. Centenary Celebrations of the University of London*, University College, June 1927). (10) Ramblings of a naturalist in Kashmir and Switzerland (*Proc. Centenary Celebrations of the University of London*, University College, 28th June 1927). (11) The forests of Kashmir (*Journal of Scientific Transactions*, British Association for the Advancement of Science, Leeds, 6th September 1927). (12) Biological relations of *Mercurialis perennis* (*Proc. Linnean Society of London*, 3rd Nov. 1927). (13) Autecology of *Mercurialis perennis* with special reference to the soil factors (Thesis approved for the degree of D.Sc. at London University, 1927). (14) Stratification of nitrates in natural soils of Lucknow in the form of Liesegang rings and the significance of this phenomenon in Agricultural practice (*Proc. Indian Science Congress*, Madras, 1929, pp. 251-252). (15) The Hydrogen-ion concentration of the soil as a factor of vital importance in governing the distribution and growth of plants (*Proc. Indian Science Congress*, Madras, 1929, p. 252). (16) The commercial plantation and exploitation of Indian medicinal plants and the need for the compilation of an Indian pharmacopœa (*Proc. Indian Science Congress*, Bangalore, 1932, p. 333). (Published in full by the Indian Press, Allahabad, 1930, pp. 1-12). (17) Bathymetrical survey of the Dal Lake of Kashmir, with special reference to the penetration of actinic rays to different depths of water and their effect on the incidence of vegetation (*Proc. Indian Science Congress*, Bangalore, 1932, pp. 328-329). (18) On the genus *Artemisia*: its species, varieties and ecads as

found in Kashmir (*Proc. Indian Science Congress*, Bangalore, 1932, p. 329). (19) On the distribution of fresh-water plants in India (*Proc. Indian Science Congress*, Patna, 1933, p. 321). (20) Invasion of *Eichhornia crassipes* in the interior of the United Provinces (*Proc. Indian Science Congress*, Patna, 1933, pp. 321-322). (21) Some observations on the anomalous distribution and ecology of *Nymphæa tetragona* Georgi (*Proc. Indian Science Congress*, Patna, 1933, p. 322). (22) The rôle of *Parrotia Jacquemontiana* Dcne, in the forest ecology of Kashmir State (*Proc. Indian Science Congress*, Patna, 1933, p. 322).

*S. K. Mukerji and T. C. N. Singh:* (23) On the adaptation of some perennial plants of the Lucknow flora to the marked periodicity of the climate (*Proc. Indian Botanical Society*, Lucknow, 1923; *Journal of the Indian Botanical Society*, **3**, p. 262).

*S. K. Mukerji, S. C. Verma and S. N. Asthana:* (24) On the ecological investigation of twelve different kinds of seedlings belonging to ten families of flowering plants from the Lucknow flora with a view to find the causes of excessive seedling mortality in nature (*Proc. Indian Science Congress*, Bangalore, 1932, pp. 329-330).

# Letters to the Editor.

## Changes in Charge, Conductivity, Stability and Composition of Colloidal Arsenious Sulphide on Exposure to Light.

It is known that arsenious sulphide sol when exposed to light becomes turbid and its flocculation value by electrolytes is lowered.[1] In our laboratory we have made simultaneous measurements of charge, conductivity, stability and composition of aresenious sulphide sol when exposed to electric light for different periods. It is observed that the charge on the colloidal particles continuously decreases while the conductivity of the sol increases with an increase in the period of exposure to light; the amount of free arsenious acid in the sol at the same time increases (the amount of total arsenic remaining the same) while the amount of total sulphur decreases somewhat. The stability of the sol as determined by flocculation values with KCl first increases and then decreases;[2] on the other hand, when $MgCl_2$ is used to coagulate the sol, the stability is found to decrease continuously.

The arsenious sulphide sol when exposed to light hydrolyses as on ageing into arsenious acid and hydrogen sulphide; the latter is photochemically oxidised to sulphur dioxide which again reacts with hydrogen sulphide to form pentathionic acid and sulphur. The sulphur adsorbs polythionate ions and passes into colloidal sulphur.[3] The decrease of the cataphoretic speed (charge) noticed by us is due to an increase of the amount of free arsenious acid in the sol produced as a result of hydrolysis of arsenious sulphide[4]. The increase of conductivity is on account of the production of free arsenious acid due to hydrolysis and of polythionic acids as a result of photochemical oxidation of hydrogen sulphide[5]. The smaller stability of the sol is due to a decrease of the charge on the colloidal particles, but the greater stability observed with KCl when the sol is exposed to light only for short periods cannot be explained on the same basis because the charge on the colloidal particles has continuously decreased; this anomaly with regard to KCl is being investigated. The fact that the total amount of sulphur in the sol decreases somewhat on exposing it to light is due to some hydrogen sulphide escaping as gas from the sol. Details of experiments and results will be published elsewhere in due course.

C. B. JOSHI.
P. M. BARVE.
B. N. DESAI.

Physical Chemistry Laboratory,
Wilson College,
Bombay 7,
*August 3, 1934.*

[1] Freundlich and Nathansohn, *Kolloid Zeit.*, 1921, **28**, 258.

[2] *Cf.* Miss Sheila Roy, *J. Ind. Chem. Soc.*, 1929, **6**, 431.

[3] Freundlich and Nathansohn, *loc. cit.*

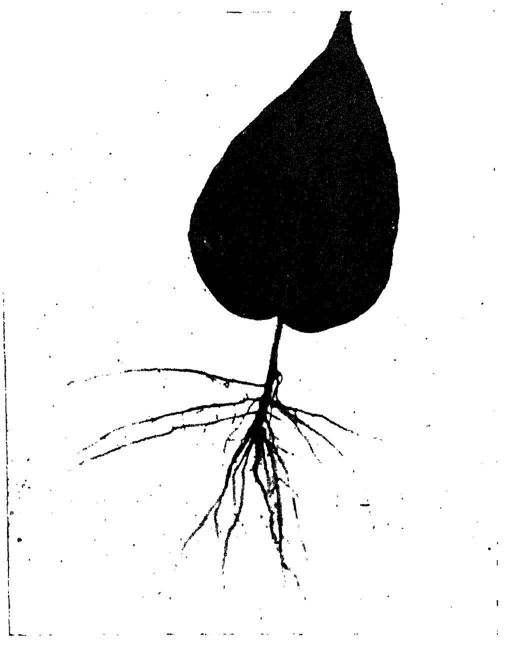
[4] *Cf.* Desai, *Curr. Sci.*, 1934, **2**, 473.

[5] *Cf.* Murphy and Mathews, *J. Amer. Chem. Soc.*, 1923, **45**, 16.

## Development of Roots from the Petiole of *Ficus religiosa* Leaf.

WHILE investigating the influence of external environmental condition (*e.g.*, factors like light, temperature, humidity, etc.) on the formation of cuticle in *Ficus religiosa*, I had an occasion to pluck some

of the leaves from the lower region of the shoot, which appeared to obstruct the fitting up of the apparatus. On the same day (17th July 1934) those plucked leaves were placed in tap water. The cuticle experiment was conducted for a fortnight. During this period the leaves remained in the same water. They did not show any sign of senescence. The leaves were examined on 31st July 1934 to find a possible cause of their remaining healthy, when some root-like structures were found to come out from the callus formed at the base of the petiole. On closer examination they were seen to be real roots with root-hairs and root-caps. On 2nd August 1934, the leaves were placed in fresh tap water, to see if any further change would take place. After a couple of days the first-



formed roots elongated and had developed root-hairs profusely. On 4th August 1934, one of the leaves with roots was placed in moist sand to see if any shoot would come out. This leaf remained healthy for 3 days, but from 7th August 1934, it began to show signs of decay. The other leaf in the meantime had borne several roots right from the severed surface up to the middle portion of the petiole. On the same date this was placed in very dilute nutrient solution (Pfeffer's). The roots elongated and fresh root-hairs came out from the elongated parts. Some roots gave out branches and the length of the individuals became gradually greater.

The leaf is quite healthy and is living till this day (17th August 1934) when the article is being sent to the press. But no shoot is coming out.

Further work on this is proceeding.

P. F. MALLIK.

Ravenshaw College,
Cuttack,
*August 17, 1934.*

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## Note on the Theory of Artificial Disintegration.

IN a recent publication[1] I (in collaboration with A. Ganguli) have given the following wave statistical formula for artificial disintegration of nucleus by $\alpha$-particles.

$$\lambda = C.\frac{\sqrt{E_1 E_2}}{h^2 r_{01}^2\ r_{02}^2\ \mathrm{Cot}\mu_{01}\ \mathrm{Cot}\mu_{02}} \times \quad .. \quad (1)$$

$$\times \exp.-\{2k_1(2u_{01}-\mathrm{Sin}\ 2u_{01})-2k_2(2u_{02}-\mathrm{Sin}\ 2u_{02})\}$$

where the suffixes 1 and 2 are respectively for the bombarding $\alpha$-particles and the disintegrating protons. The above formula has been shown to be in good agreement with experiment. The discontinuities in the curve lately found by Chadwick and others[2] can be explained from the above formula on assuming the existence of different groups of protons within the nucleus. Investigation in this direction has already been taken up by M. Ghosh. It should also be noted that the above formula is perfectly general and may be used for any other class of nuclear artificial disintegration.

Since the paper has been published, my attention is drawn to a recent article on the subject by Th. Sexl.[3] After elaborate analyses Sexl finds that the absorption coefficient ($a$) for the $\alpha$-particles is given by (in the present notation).

$$a \sim e^{-2k_1(2u_{01}-\mathrm{Sin}\ 2u_{01})} \quad .. \quad (2)$$

Since $\lambda \propto a$, formula (2) obviously corresponds to the first part of my formula (1), which follows directly from the assumption of a viscous phase space for the nucleus.

We should also note that the second part of equation (1) representing the disintegrating protons is taken with a positive sign in the

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[1] *Curr. Sci.*, 1934, **2**, 471.
[2] *Proc. Roy. Soc.*, **130**, 463 ; **135**, 48.
[3] *Zeit. f. Phy.*, 1934, **87**, 105.

exponential, whereas in the case of spontaneous disintegration the sign is negative. The solution of the relevant differential equation gives both the signs.[4] As usual we are to fix the sign from a physical consideration of the problem. From the principle of conservation of energy we find that for a given velocity of the bombarding $\alpha$-particle the number of protons coming out of the nucleus with a higher velocity is less. So the sign must be taken positive. Conditions are, however, different when the emission is spontaneous.

Lastly, we may remark that in his above treatment Sexl appears to think that when the limit of approach of the bombarding $\alpha$-particle is zero, there is usual Rutherford scattering but if, instead, the limit is $r_0$ there is an additional term in the perturbation function which represents disintegration. But after Mukherjee's well-known wave statistical theory[5] of anomalous $\alpha$-scattering based on the assumption of a critical radius $r_0$, the above idea of Sexl should, I think, be discarded.

K. C. KAR.

Physical Research Laboratory,
Presidency College,
Calcutta,
*August 28, 1934.*

## Determination of e/m and Mass of Individual Charged Particles in Colloids.

IT is of great interest to determine the size and mass of *individual* particles in colloids, as the methods hitherto employed give only the *average* values, which are more or less incorrect. I have therefore been working out different methods for the determination of the mass, size and the ratio of the charge to mass of *individual* particles in colloids. One of these has been briefly mentioned in a previous note.* A short account of another method which has been worked out successfully by me is given below:—

The colloid under examination was contained in a cataphoresis cell, which was so fixed in the ultramicroscope that, when an electric field was applied across the electrodes, the colloidal particles moved up or down depending on the direction of the field. The eye-piece was fitted with a micrometer scale. Any single particle was selected in the field of view of the ultramicroscope. Then an electric field of 80 or 100 volts was applied across the electrodes and the velocity ($v_1$) of the motion of the single particle in a vertically *downward* direction, *i.e.*, under the combined influence of the electric and gravitational fields, was found. The electric field was then reversed, and the velocity ($v_2$) of the movement of the same particle in a vertically *upward* direction with the force of gravity acting against the electric field was found. Then we have

$$\frac{V_1}{V_2}=\frac{Xe+4/3\pi r^3\,(d_1-d_2)\,g}{Xe-4/3\pi r^3\,(d_1-d_2)\,g};\quad \text{or}\quad \frac{V_1+V_2}{V_1-V_2}=\frac{Xe}{m.g.c}$$

(X is the applied electric field, $e$ the charge of the particle, $m$ its mass, $g$ the gravity constant, $d_1$ and $d_2$ the densities of the particle and the medium respectively). X, $g$ and $e$ are constants, the values of which are known. Knowing further the values of $V_1$ and $V_2$, which have been determined experimentally, the value of e/m for each individual colloidal particle observed in the field of the ultramicroscope could be calculated.

Comparison of the values of e/m for several particles has shown that the value of e/m for a certain set of particles is practically the same, that for others a simple multiple of the former, and so on. It is, however, necessary to work with a large number of such particles before a generalisation can be made. I am therefore continuing this investigation and extending it to a number of colloidal systems.

K. KRISHNAMURTI.

College of Science,
Nagpur,
*August 29, 1934.*

## The Development of the Female Gametophyte of *Ludwigia parviflora*, Roxb. and *Jussieua repens*, Linn.

THE family Onagraceæ has long been of interest to the morphologist and cytologist. The added importance given to it by the series of papers recently published by Dr. Donald A. Johansen of the Stanford University, has prompted us to give here a brief report of our own observations on the development of the embryo sac in two plants of this family, which we had the occasion to collect in our trips to places near about Agra.

[4] *Vide* solution by Riccatti's method given by Sexl, *Zeit. f. Phys.*, 1929, **56**, 92.

[5] *Phys. Zeit.*, 1933, **34**, 175.

* *Curr. Sci.*, 1934. **2**, p. 387.

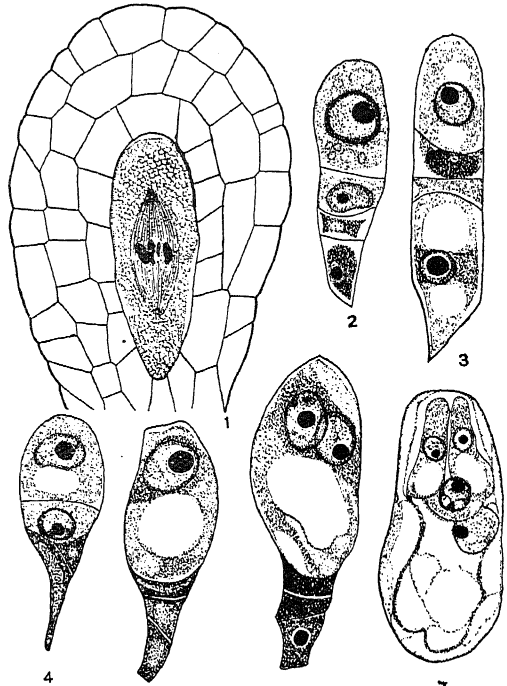
Both the plants are found only in marshy habitats, but the second—*Jussieua repens*—thrives best in water. The ovary is completely inferior, four to five-celled, and has rows of numerous tiny ovules arranged on the axile placentas. In *Jussieua repens* two leaf-like appendages are present on the ovary which do not, however, give a clear indication of the presence of xylem and phloem.

The ovules are anatropous and since there is a gradation in their rate of development, a fair number of stages can be obtained from a single ovary if suitably cut. In later stages the ovules become bent and pressed towards the central axis—an arrangement evidently designed to facilitate the entry of the pollen tube. In *Jussieua* the curvature of the ovules continues till they become completely curved over with the micropyle pointing upward. In *Ludwigia* there is no uniformity, but the longitudinal axis of the ovule usually lies at right angles to the placenta with the micropyle turned inwards. There are two integuments, but the outer is not developed towards the side of the funiculus. Neither a hypostate nor epistase develops in any of the two species.

Usually there is a single hypodermal archesporial cell, but the adjoining cells of the nucellus sometimes resemble this so closely that it is difficult to distinguish it clearly from them. The primary wall cell in *Jussieua* gives rise to an extensive parietal tissue, but in *Ludwigia* only two layers are formed in most cases. Occasionally the epidermal cells of the nucellus also divide at certain points in *Jussieua*.

The megaspore mother cell (Fig. 1) gives rise to a tetrad of four megaspores which are usually arranged in a single row, but in *Ludwigia* it occasionally happens that the cell-wall laid down in the chalazal dyad is oblique (Fig. 4) or even perpendicular in the latter case the megaspores become arranged in the form of an inverted "T". In *Jussieua* two tetrads are occasionally present in the same nucellus.

The micropylar megaspore alone functions in most cases, but the chalazal often enlarges considerably and both may continue to grow for some time (Fig. 3). More rarely the upper two may enlarge and the two at the chalazal end may be the first to degenerate (Figs. 2 & 4). In most cases the remains of the three degenerating megaspores can be easily made out in both genera even up to the time the embryo sacs are ready for fertilisation.




**Figs. 1-7.**

All figures are of *Ludwigia parviflora* and have been reproduced at a magnification of ×625.

During the enlargement of the micropylar megaspore a vacuole appears at its lower end so that the nucleus always lies at the top (Fig. 5). Here it undergoes two divisions giving rise to 4 nuclei (Figs. 6 & 7) of which three take part in the formation of the egg apparatus and the fourth functions as the single polar nucleus. As in the other Onagraceæ, so far investigated (except *Trapa*) there are no antipodals nor a lower polar nucleus.

Sterility of ovules was common in both the plants. In *Ludwigia* several cases were seen where both the nucellus and embryo sac were absent and only the integuments were left. Degenerations might set in at any stage, but are more frequent in later stages.

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BABU LAL GUPTA.

Agra College,
Agra,
*August 31, 1934.*

## A Case of Ovoviviparousness in Adult Gall Midges *(Itonididæ)*.

KHALE[1] first recorded the remarkable phenomenon of ovoviviparousness in gall midge larvæ. Later Felt[2] described this type of pædogenesis in the genera *Miastor* Mein, and *Oligarces* Mein. But the only reference in the literature to this habit in the adult gall midges is by Cotes[3], who records that Wood-Mason believed the "silver-shoot" gall midge of paddy *Pachydiplosis oryzæ* Wood-Mason, to be viviparous.

While recently working on the Indian forms of this family, I came across an undoubted case of this habit in the adults of a new species[4]. The abdomen of a female of this species was observed to be heavily loaded with numerous cylindrical, apodous larvæ, which were at first believed to be those of Hymenopterous parasites. Subsequent observations, however, proved to the contrary and it was found that they were true Itonid larvæ, hatched from eggs inside the abdomen of the mother.

After pairing of the midges, the eggs are fertilised but are not deposited by the female. The larvæ are hatched from them, retained and nourished in the abdominal cavity of the parent midge. Living maggots are then deposited after twelve days on decaying vegetable matter. When freshly extruded they are about 1 mm. long and yellowish-white in colour. Some of them are already in a far-advanced stage of development and immediately turn into pupæ. Others, however, feed on the decaying vegetable matter and pupate after a further period of development extending over a month. The adults emerge in about five days.

This habit seems to be of great advantage to the species in two ways. Not being so helpless as eggs, the larvæ have a chance of escaping parasitisation. When sufficient food is lacking, some at least of the larvæ, already well developed, can immediately pupate after being laid and turn into adults, thus providing against the entire extinction of the generation.

M. S. MANI.

Entomological Section,
Zoological Survey of India,
Indian Museum,
Calcutta,
*September 1, 1934.*

[1] Khale, W., "Die Paedogenesis der Cecidomyiden," *Zoologica*, 1908, **55**, 21, 1-80.

[2] Felt, E. P., "*Miastor americana* Felt, an account of Pedogenesis," *Bull. N. Y. St. Mus.*, 1911, No. 147, 82-104.

"Biology of *Miastor* and *Oligarces*," *Science*, 1912, **33**, 278-280.

[3] Cotes, E. C. "Notes on Indian Economic Insects," *Ind. Mus. Notes*, 1890, **1**, 103.

[4] This new species is described in a paper shortly to appear in the Records of the Indian Museum under the name *Thurauia chilkaensis*, sp. nov.

## Exembryonate Seeds.

IN their interesting note recently published Joshi and Rao[1] record the formation, in *Tinospora cordifolia*, of fruits and seeds which are outwardly normal although devoid of all trace of an embryo. There is no evidence of fertilisation, indeed, even of pollination; the egg-apparatus and antipodal cells of the otherwise normal embryo-sac degenerate early, but a copious endosperm results from the fusion of the two polar nuclei; there is, of course, no triple fusion. The ovary ripens into a healthy, fleshy fruit, containing seeds which are normal except for the absence of an embryo.

The authors suggest a comparison with the case of *Cycas revoluta* recorded by Kashyap in 1921, where foreign pollen may possibly provide the necessary stimulus to the further development of the ovule[2]. But they do not refer to an important paper published earlier, in which le Goc[3] proved the influence of foreign pollen on the development of the ovule of *C. Rumphii*. In the *Tinospora*, however, there is no question even of foreign pollen. A palæbotanist is at once reminded of the fact that so many of the best preserved palæozoic gymnosperm "seeds" are totally devoid of an embryo. This fact has generally been explained on the analogy of the modern *Ginkgo*, where fertilisation is said to take place after the ovule has fallen to the ground. No such explanation will, however, apply in the present case.

But how does the *Tinospora* seed *germinate*, if at all? Whence does the *seedling* take its birth? These are obvious questions on which, it is a pity, the authors are silent. Does the endosperm itself function here as an embryo? It has been

[1] *Curr. Sci.*, 1934, **3**, 2, 62.

[2] Kashyap, *Journ. Ind. Bot. Soc.*, 1921, **2**, 120.

[3] le Goc, *Ann. Roy. Bot. Gard. Peradeniya*, 1917, **6**, **3**, 187.

suggested, rather acutely, that the endosperm of the higher flowering plants is in its morphological nature a sort of embryo. No doubt the authors will pursue their enquiry, in due course, into these matters.

B. SAHNI.

The University,
Lucknow,
*September 2, 1934.*

## On the Development of the Dorsal Arcualia in the Cervical Vertebra in Chelonia.

PREVIOUS workers[1-5] on the development of the vertebral column of Chelonia, have stated that the dorsal arcualia of the cervical vertebræ are formed from the cartilaginous basidorsals of either side to complete the neural arch. But our recent investigation disproves their findings. Mookerjee[6] has shown that in the vertebral column of Urodela the cartilaginous basidorsals of the corresponding vertebræ are situated at the middle region of the centrum. There is a third piece of cartilage, the supradorsal, which intervenes between the basidorsals of either side and leads to the completion of the cartilaginous arch. Besides this, at the anterior and posterior portions of this cartilaginous arch, there are two connective tissue arches which complete the dorsal arcualia of each vertebra. These connective tissue arches become osseous without going through the stage of chondrification, and they are thinner in cross-section than the cartilaginous basidorsals mentioned above. An identical condition, as detailed above, has been shown recently by Mookerjee in collaboration with Chatterjee[7] in the vertebral column of snakes. Now a similar condition has again been observed by us in the vertebral column of Chelonia (Figs. 1-5).

It may further be pointed out that in the intervertebral region of *Chrysemys* structures like the zygosphenes and zygantra or the fibrous tissue, characteristics respectively of snakes and newts[7] are not found; but the intervertebral region of *Chrysemys* comes closer to the anuran condition in as much as

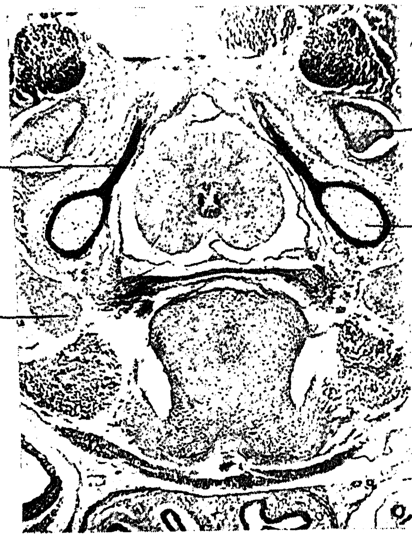


**Fig. 1.** ×40

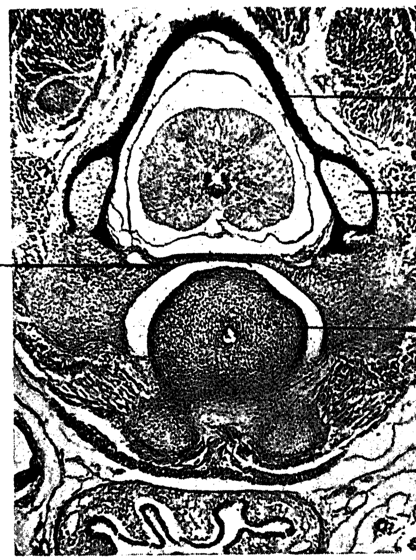


**Fig. 2.** ×42·5

a big gap exists between the two successive vertebræ.

Mention may also be made here of the fact that in the second vertebra of *Chrysemys*

[1] Gegenbaur, C., *Untersuchungen zur vergleichenden Anatomie der Wirbelsaule bei Amphibien und Reptilien*, Leipzig, 1862.

[2] Hoffmann, C. K., *Bronn's Klassen unf Ordnungen des Tierreichs*, 1890, Bd. VI, Abt. 3.

[3] Gadow, H., *Phil. Trans. Roy. Soc.*, 1896, **187 B.**

[4] Gadow, H., *The Evolution of the Vertebral Column*, Cambridge, 1933.

[5] Procter, J. B., *Proc. Zool. Soc. London*, 1922.

[6] Mookerjee, H. K , *Phil. Trans. Roy. Soc.*, 1930, **218 B.**

[7] Mookerjee, H. K., and Chatterjee, B. K., *Curr. Sci.*, 1934, **2**, 434-436.

there is a dorsal spine, which is an outgrowth at the mid-dorsal region of the anterior connective tissue arch. This could not, however, be found in other cervical vertebræ.

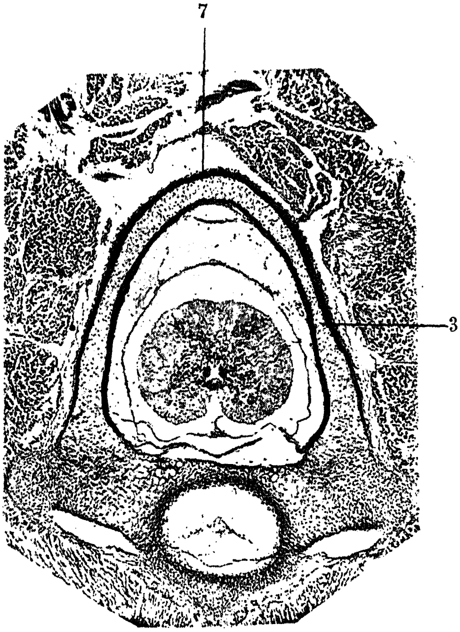


**Fig. 3.** ×36

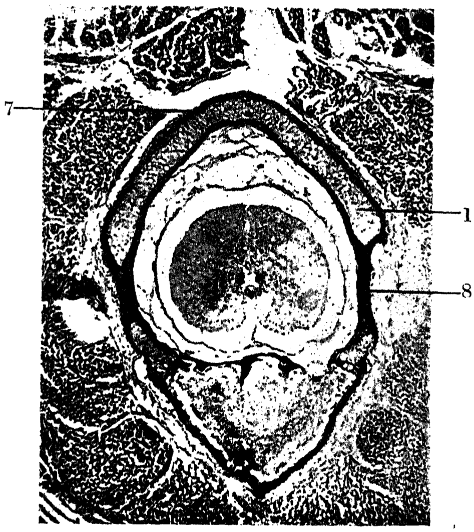


**Fig. 4.** ×40

For the sake of comparison we have given the side view of two consecutive adult cervical vertebræ (Fig. 6) and have marked those planes through which the transverse sections would have passed. Figs. 1 to 5 correspond more or less with the markings on the adult vertebræ.

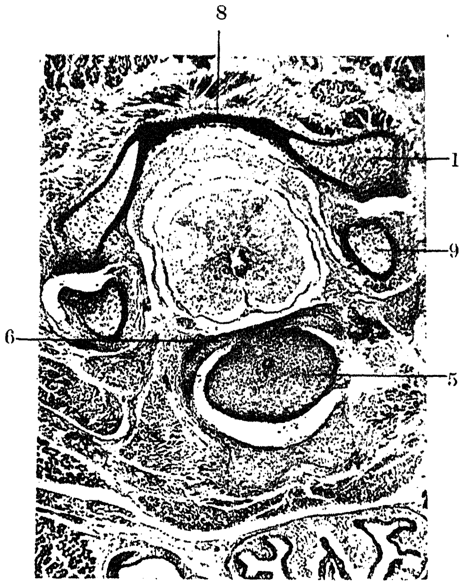


**Fig. 5.** ×35

**Figs. 1—5.** Serial transverse sections through different regions of a cervical vertebra of *Chrysemys marginata* at 15 mm.

1. *Postzygapophysis.*
2. *Anterior connective tissue arch.*
3. *Cartilaginous basidorsal.*
4. *Spinal nerve ganglion.*
5. *Condyle of the vertebra.*
6. *Socket of the vertebra.*
7. *Supradorsal.*
8. *Posterior connective tissue arch.*
9. *Prezygapophysis.*

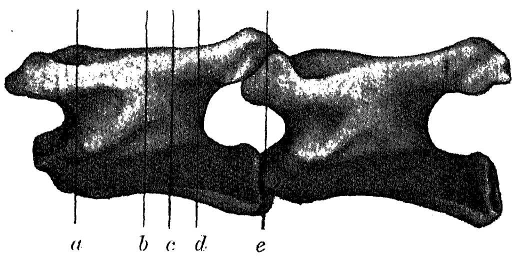


**Fig. 6.** ×11

Side view of two consecutive adult cervical vertebra of *Chrysemys marginata*.

*a*. *b*, *c*, *d* and *e* are the planes through which Figs. 1 to 5 have passed.

HIMADRI KUMAR MOOKERJEE.
AMAL KRISHNA MUKHERJEE.

Department of Zoology,
University of Calcutta,
*September 4, 1934.*

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## An Automatic Device for Maintaining Constant Pressure.

WHILE developing a new type of pendulum oscillating in an evacuated chamber, considerable difficulty has been experienced in maintaining the required pressure of about 1 mm. of Hg. Due to the large size of the chamber and the numerous joints involved in the construction, a small leak was unavoidable. An automatic arrangement was therefore developed and found to maintain the pressure inside the chamber constant to within ± 0·5 mm. of mercury. The platinum electrodes $K_1$ and $K_2$ are fused into a manometer as shown in Fig. 1. $K_1$ is in permanent contact with mercury while $K_2$ is at some height determined by the desired pressure in the chamber. As soon as a leak develops, the mercury rises in the manometer and completes the circuit of the relay R which switches on the motor; the latter runs till the pressure in the chamber falls to the previous value. It might at first appear that, once the motor has started, it will stop almost immediately (due to the rapid fall of the mercury column in the manometer) resulting in jerky operation. But owing to capillary attraction, the surface of mercury remains in contact with the platinum point for an appreciable length of time, thus ensuring smooth performance. On one occasion, the motor was switched on once every 40 minutes and was kept running each time for 20 seconds.

If a larger variation of pressure is permissible the adaptation of a thermal time delay device in the relay circuit further smoothens the operation by keeping the motor running for some time after the manometer contact breaks.

The time delay device (Fig. 2) consists of a compound strip of brass and iron, rivetted together. After insulating the strip with asbestos paper a few turns of nichrome wire are wound over it. The rate of heating, the size of the strip and the heat insulation determine the period of delay. The compound strip on being heated by the current switched on by the manometer relay, bends and switches on the motor. Even though the mercury column in the manometer breaks the heater current, the contact is maintained a little longer owing to the heat capacity of the strip. A strip of 4 cm. ×

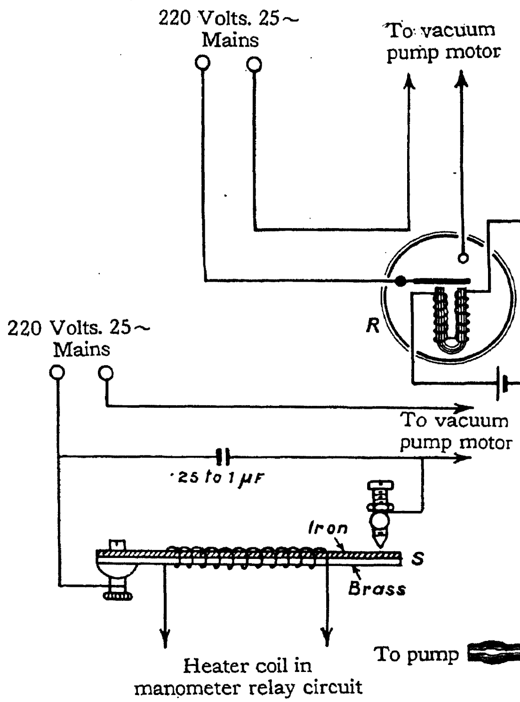


Fig. 2.

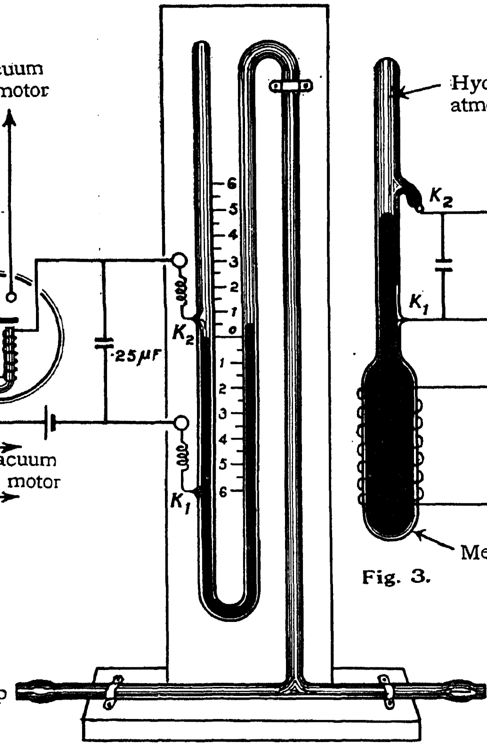


Fig. 1.

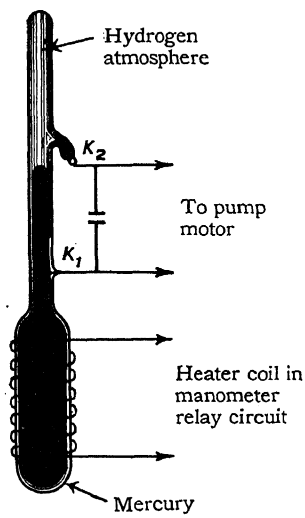


Fig. 3.

1 cm. × 0·1 cm. wound with 20 turns of No. 30 nichrome wire is found to give a time delay of 2 minutes.

A more satisfactory time delay arrangement is a thermally-operated mercury switch as shown in Fig. 3. This arrangement permits greater flexibility. The size of the bulb, the bore of the strip and the rate of heating determine the period of contact and can be adopted to individual requirements within wide limits. The atmosphere of hydrogen prevents heavy sparking and fouling of the contact surfaces.

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Bangalore, *September* 5, 1934.

### Influence of High Temperature on the Raman Bands of Benzene.

FUJIOKA[1] studied the Raman spectra of a few organic liquids at 10°C and at 100°C and found that in the case of benzene the two Raman lines 1584 cm.$^{-1}$ and 1603 cm.$^{-1}$ are remarkably broadened at 100°C and generally those lines which are diffuse at room temperature become slightly broader at 100°C. He attributed this broadening of the diffuse lines with rise of temperature to the increase of rotation of the molecules. Since comprehensive theories about the structure of the Raman bands have subsequently been put forward by Placzek[2] and Placzek and Teller[3] it is easy to understand now the changes which the Raman lines may undergo with rise of temperature. The Raman spectrum of benzene has therefore been investigated more carefully at different temperatures in the range 35°C to 160°C. The microphotometric records of the Raman spectra of benzene at 35°C and 160°C are reproduced in Fig. 1.

A comparison of the Raman spectra of hot and cold benzene shows that many of the lines undergo changes at high temperatures. The lines 1584 cm.$^{-1}$ and 1603 cm.$^{-1}$ are found to become broader at high temperatures as observed by Fujioka. Besides this, the following changes not reported by Fujioka are also observed. The Raman line 603 cm.$^{-1}$ excited by both the mercury lines 4046 Å and 4358 Å, though fairly sharp at the room temperature, becomes much broader at high temperatures. The band 3047 cm.$^{-1}$ excited by 4358 Å not only becomes broader but also its intensity diminishes at high temperatures. The line 1180 cm.$^{-1}$ excited by 4358 Å seems at first sight to be broadened very much but the same line excited by 4046 Å does not undergo much change with the rise of temperature. On closer examination it is found that the Raman band 2945 cm.$^{-1}$ excited by 4046 Å is just superposed on the line 1180 cm.$^{-1}$ excited by 4358 Å and is very feeble at the room temperature but its intensity as well as the width increase with the rise of temperature so that at high temperatures the line 1180 cm.$^{-1}$ is masked by it. Thus it is the line 2945 cm.$^{-1}$ which undergoes the change and not the line 1180 cm.$^{-1}$ The lines 3047 cm.$^{-1}$ and 2945 cm.$^{-1}$ seem to be intimately connected to each other, because as the intensity of the former diminishes with the rise of temperature that of the latter increases. This change in the relative intensities of the Raman lines with the change in the temperature is different from that predicted by Placzek's theory, because the latter change can take place only in the case of lines of small frequency shifts. The influence of higher rotational and vibrational states seems to bring about a slight deformation of the molecule, so that the change in the polarisability in the case of one of the vibrations diminishes while that in the other case increases. The only other change observed at high temperatures is the usual increase in the intensity of the anti-Stokes line 990 cm.$^{-1}$ The width of the lines 990 cm.$^{-1}$ and 3060 cm.$^{-1}$ does not change with the rise of temperature.

The observed increase in the width of the line 603 cm.$^{-1}$ with the rise of temperature may be due to anharmonicity, because the vibration frequency being low, it is possible for a considerable fraction of the molecules to possess initially a vibration quantum number greater than zero, and according to the theory, the width of the line in the case of anharmonic vibrations depends slightly on the initial quantum number $v_J$. In the case of the lines 2945 cm.$^{-1}$ and 3047 cm.$^{-1}$, however, the frequencies being great, the observed broadening cannot be due to anharmonicity. Theoretically, if the vibrations are not total symmetric but cause a degradation of the symmetry of the molecule, the whole

[1] Y. Fujioka, *Sc. Pap. Inst. Phys. Chem. Res. Tokyo*, 1929, **11**, 205.
[2] G. Placzek, *Zeit. f. Phys.*, 1931, **70**, 84.
[3] G. Placzek and E. Teller, *Zeit. f. Phys.*, 1933, **81**, 209.

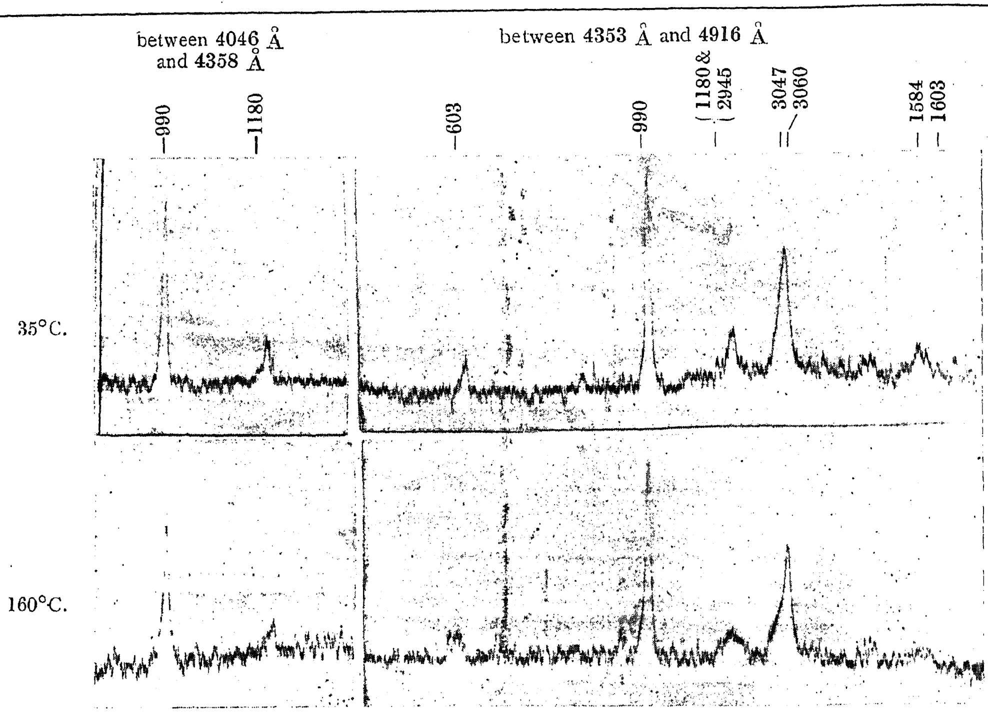


**Fig. 1.**

intensity of the corresponding Raman lines is due to anisotropic scattering depending on the orientation of the molecule. Such a Raman band possesses a structure consisting of ten branches. The frequency shifts of these branches from the centre of the band depends on J and K, where J and K are the quantum numbers of the total rotation impulse and that along the axis of the molecule respectively. The probability of higher values of J and K increases with the rise of temperature and consequently the width of the band also increases.

It is easy to understand why the width of the lines 990 cm.$^{-1}$ and 3060 cm.$^{-1}$ does not increase with the rise of temperature. These lines being due to total symmetric oscillations the intensities of the central lines are due to "spur" scattering, *i.e.*, scattering contributed by the diagonal sum of the matrix elements of the tensor representing the change of polarisability. Such a scattering is independent of the rotation of the molecules. There is, however, an accompanying rotational wing, but it is as feeble in comparison with the central sharp line as the wing accompanying the Rayleigh line is in comparison with Rayleigh line itself.

The author's thanks are due to Prof. D. M. Bose for his kind interest in the work.

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University College of Science,
92, Upper Circular Road,
Calcutta,

*September 6, 1934.*

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## Lilac Ortho-Pyroxenes from Koratagere (Mysore State).

AMONG the outcrops which form the suite of Cordierite-hypersthene rocks near Bidaloti (Lat. 13° 31′ N.; Long. 77° 17′ 30″ E.) in Koratagere taluk, are a few which show a peculiar violet or lilac ortho-pyroxene. This is the first instance in which such a type of ortho-pyroxene has been noticed in Mysore and so far as we are aware, its occurrence has not been recorded elsewhere either. In microsections the mineral shows the usual characteristics of hypersthene, *i.e.*, straight extinction, negative sign and pleochroism but differs from it in having a lower refractive index, a lesser intensity of pleochroism and a different scheme of axial colours as noted below:

X = yellow.
Z = Y = lilac to lavender.

The mineral is closely associated with the normal pink to green pleochroic hypersthene, cordierite and biotite, and it is probably a derived species from the reconstruction of the altered products of the latter two minerals. Detailed investigations regarding its optical and chemical characters, etc., are being carried on and the results obtained will be published elsewhere in due course.

B. RAMA RAO.
M. B. RAMACHANDRA RAU.

Mysore Geological Dept.,
Bangalore,
*September 7, 1934.*

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## The Open Pan System of White Sugar Manufacture.

IN the note published in the July issue (p. 24) of *Current Science* Dr. Iyengar was somewhat unkind to the growing industry, having perhaps overlooked the extreme limitations of the modern factory system. In view of our unique agricultural and market conditions, the ultimate scope of the vacuum plants may be estimated at 15 per cent. of the total sugar produce of the country; whereas the open pan system, the output of which already equals that of the large centrals, has a fair chance of superseding the primitive methods of *gur* manufacture, if further technical development is forthcoming.

Dr. Iyengar's figures relating to low sucrose recovery by the open pan process curiously fail to discourage the average *Khandsari* which, with simple equipment, turns out 5 per cent. white sugar and 6 per cent. *gur* of marketable quality as against Indian factory averages of 5 per cent. first sugar, 4 per cent. inferior grades and 4-5 per cent. waste as molasses. Nor does the comparatively inefficient milling, which yields about 15 per cent. less juice than the elaborate tandem of the factory, constitute an entire disadvantage as the absence of the additional impurities that would result from multiple crushing serves to render the by-product edible.

Open pan boiling *per se* is not an unsound proposition, if it is recognised that one of the most expensive complications of the modern central, *viz.*, vacuum evaporation, although desirable on economic grounds when dealing with several hundreds of tons of juices daily, can be dispensed with by the small manufacturer with little appreciable damage to the juices. In fact, up-to-date factories in Europe evaporate beet juices under *pressure*, the issuing vapours serving as process steam for auxiliary purposes.

The possibilities of the open pan process cannot be gainsaid, as further investigations might lead to the evolution of a cheap manufacturing unit yielding with minimum waste, a product that might satisfy non-fastidious consumers and serving the interests, needs and limitations of the agricultural classes as no expansion of the modern factory system can.

L. GOPALA RAO.

Indian Institute of Science,
Bangalore,
*September 11, 1934.*

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I AM not in the least unkind to the open pan industry but am simply looking at hard facts in the face. Since the days of "Hadi Process" the open pan system is surely making sugar during a period of over 20 years, but still the factory system has made enormous strides during the last three years.

The one point at issue is that the open pan system of making white sugar cannot compete with the factory system, and is bound to disappear in course of time just as it has already done in other countries. Similarly even the small inefficient sugar factories are bound to make room for large efficient ones.

The open pan system has certainly a place in the production of *gur* from pure cane juice and not from a mixture of juice and molasses or from molasses. Any improvements in that direction are certainly welcome in the interests of the small cultivator who produces *gur* for eating and not refining purposes.

During the period that the sugar tariff lasts, I think serious efforts should be made to put the sugar industry on a sound basis so as to be able to compete with foreign sugar in the Indian market even if the tariff is removed. Efforts to improve the open pan system are not likely to achieve much more than what has been done during the last 20 years, and may even give a set back to the sugar industry in the long run.

If facts and figures are brought forth to prove that the *Khandsari* can make more money by making sugar than by making *gur* of good quality, then I am prepared

to revise my views. As it is, when *gur* is selling at about ½ the price of sugar, people interested in the industry think it not at all worth while to make sugar but make only jaggery.

B. N. IYENGAR.

Dept. of Agriculture, Mysore,
Bangalore,
*September* 12, 1934.

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### The Multiplication of Scientific Societies.

AMONG the interesting items included under the head of Science Notes in the August number of *Current Science* is an announcement of the formation of a Biochemical Society in Calcutta. Immediately above this item is a notice of a joint meeting in Bombay of the Society of Biological Chemists, India, and the Grant Medical College Physiological Society. The need for another Biochemical Society is therefore hardly apparent.

The incident is only too characteristic of the fissiparous tendency apparently inherent among Indian organised bodies, scientific and other.

Some time ago there was a movement for the foundation of a "Society of Applied Chemistry" in Bombay, regardless of the fact that the "Institution of Chemists (India)" was doing much the same kind of work, not without difficulty, in Calcutta.

Apart from the expense and trouble of maintaining separate literature and collecting separate subscriptions, a much more serious result of this multiplication of scientific societies is the increased isolation of scientific workers. Even if an individual can afford the expense to subscribe for and the time to look through the various publications containing the papers in which he may be interested, it all adds unnecessarily to the difficulty of keeping intelligently in touch with scientific progress.

In the majority of cases it is likely that only a few papers are read concerned with the particular corner occupied by the subscriber to the specialist publication.

I have long felt and advocated that all *chemical* work done in India, whether "pure" or "applied", "specialist" or "general," should come under the cognizance of the Indian Chemical Society.

There would seem no reason why the different societies should not be affiliated to the Indian Chemical Society so that they may work together as a single organisation.

All papers read at these affiliated Societies might be offered either in full or in abstract for publication in the *Journal of the Indian Chemical Society.* It will doubtless be convenient for these "affiliated" papers to be published together in sections under the heads of "Biochemistry", "Applied Chemistry," etc., and such sections to be available, if necessary, at reduced prices to readers not full members of the Indian Chemical Society.

While geographical conditions may render necessary local bodies of more or less independent personnel, a central medium of publication through the good offices of the Indian Chemical Society would seem to be called for in order to maintain the breadth of outlook which is so greatly needed in present-day India.

Business details such as the proportion of subscriptions to be paid to the central and local societies should not be difficult to arrange, on the lines adopted by such bodies as the Institute of Chemistry and the Society of Chemical Industry, and others, in giving financial support to their local sections.

GILBERT J. FOWLER.

Central Hotel,
Bangalore,
*September 8, 1934.*

# Note on Excavations in a Prehistoric Site at Kilpauk, Madras.

By M. D. Raghavan and T. G. Aravamuthan.

THE existence of a prehistoric cemetery in Kilpauk, Madras, has been known for about twelve years past, but only to a few persons interested in prehistoric archæology.[1] The site is included in the garden of the bungalow 'Fontenoy', which belongs to Mr. E. R. Prudhomme and is situated on Hall's Road, Kilpauk. Mr. Prudhomme had collected the pottery he unearthed in laying out his garden, the finds including a small sarcophagus and small vessels of various types among which could easily be recognised the black-tipped ware, with rim and inside black and the rest red, which is a dominant feature of the pottery found at Adichanallur in the Tinnevelly District. Attention has been called to the great resemblance which South Indian prehistoric pottery bears to the pottery of pre-Dynastic Egypt.[2] No attempts having been made so far to explore the site, we deemed it desirable to excavate the site methodically and collect the antiquarian remains for the Madras Government Museum to which we are both attached.

With the kind permission and encouragement of Mr. Prudhomme we started in August 1934, excavating at a spot which appeared likely to yield favourable results. Excavations are still proceeding.

The first day's excavation was fruitless. The next day, however, what appeared to be the rim of an urn was revealed, and it turned out to be a big-sized cinerary urn, with its sides badly broken, though the contents helped to keep them in position. The arrangement of the smaller vessels, both inside and around, was of great interest. These were vessels of different shapes and among them were specimens of the black-tipped ware referred to above and some fine specimens of all-black pottery.

Further excavation yielded more specimens of all-black ware, a figurine of black pottery of high polish, apparently representing a bird, and a half of a fine specimen of a pottery bead. Two iron objects were also found, one a small hoe-blade of a very primitive type, with a slightly curved cutting edge and a narrow butt, and the other a stick of iron, about 6 inches long, found broken in two, all highly oxidised.

Subsequent excavations have unearthed a sarcophagus about six feet in length, standing on six pairs of short legs. It resembles the specimens found at Pallavaram and Perumbair. It has, however, been so badly damaged by the roots of a mango tree growing close by that all attempts to raise it whole have failed. It is accordingly being removed in sections. It was found filled with sand and fragments of pottery. A bit of a bone was found close to it which is identified as the head of a human tibia. The deposits are generally found at depths varying from 3 to 7 feet below the surface, buried in a bed of 'river sand'. The site is being mapped out and stratigraphical records are being kept.

While the present finds exhibit characters common to other prehistoric sites in the Presidency, they present distinctive features which mark them off from previous finds. While no sarcophagus was found at the Tinnevelly site, urn burials alone being in evidence,[3] both the types occur at the Kilpauk site as at Perumbair. The scarcity of iron objects among the associated finds, furnishes another parallel with Perumbair. There is, however, a marked difference in the nature of the pottery found. Unlike Perumbair, the Kilpauk site is rich in fine pottery and abounds in bowls of black-tipped ware which are comparatively rare at Perumbair. The fine all-black vessels of the Kilpauk site distinguish it from both the Adichanallur and the Perumbair finds. The black pottery figurine, perhaps a votive offering, is a significant find as such figurines have not been met with in similar sites, excepting the Nilgiri cairns.

A number of handicaps attend any attempt at establishing the chronology of the South Indian prehistoric cultures. The distinctive characteristics of this find, and its chronology in relation to the other finds

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[1] It is probably this site that Mr. L. A. Cammiade refers to as a large prehistoric cemetery in the vicinity of Chetpet, Madras, in his paper in the *Indian Antiquary*, **LXI**, 21-3. Mr. Prudhomme tells us that Mr. Cammiade inspected the site about twelve years ago and saw the pottery that had been collected then and the sarcophagus we came across.

[2] By Henry Balfour, F.R.S., in *Man*, September 1932, No. 251.

[3] A. Rea, *Cat. of Prehistoric Antiquities: Adichanallur and Perumbair*, 47.

in South India cannot be determined till the excavations are completed and the excavators have had further time to study the finds in detail. All that can be said at present in regard to the age of the site—and that tentatively,—is that the pottery found appears typical of the Iron Age pottery found at other prehistoric sites in South India such as those at Adichanallur, Perumbair, and Raigir in Hyderabad, and that the character of the associated finds of pottery bead and iron objects point to the finds being assignable to the Iron Age in South India.

## Prophylactic Antimeningococcus Vaccine.

By Lt.-Col. H. E. Shortt, I.M.S.,
*Officiating Director, Central Research Institute, Kasauli.*

THE recent comparatively high prevalence of cerebro-spinal meningitis all over India has necessitated the Public Health Authorities taking all means in their power to check the disease. The fact that the disease has appeared in mild epidemic form in nearly every part of India, and the modern facilities for rapid transport which now exist. have emphasised the need to regard the outbreaks seriously and to employ every method, general or special, to prevent the menace assuming greater proportions.

Apart from general measures of public health two lines of attack are available, *viz.*,

(*a*) to treat the disease efficiently in those attacked;

(*b*) to prevent the disease by the use of a suitable prophylactic vaccine.

The only effective method of treatment of the disease is by the use of Antimeningococcus serum but even this method has given very varying results in different countries. The cause for this is not certain but probably several factors are involved such as varying virulence of strains, varying methods of preparing the serum and inadequate technique in dosage and methods of administration, including the continuous bacteriological control required in the treatment of cases. These factors, combined with the cost of the serum, ruled out its extended use in India except in large towns with good hospital and laboratory facilities.

There remained the second method of control and the Public Health Commissioner with the Government of India decided on the preparation of a prophylactic vaccine which could be used to immunise those exposed to possible infection in districts where the disease was known to be prevalent.

Such a vaccine had already been extensively used in Turkey with results reported to be favourable.

In pursuance of this policy an officer of the Central Research Institute was deputed to collect Indian strains of *Meningococcus* from cases of the disease occurring during the recent epidemic. It was not possible in the time available to collect these from all over India but, besides those locally obtained in the Punjab and Delhi, cultures were sent to the Central Research Institute for comparison from the Haffkine Institute, Bombay, which had been collected in South India. A comparison of these with the Northern India strains showed them to belong to the same types of *Meningococcus* so that the Delhi strains were considered as probably suitable for the preparation of a vaccine which would be effective all over India. Later work in England with cultures of these strains sent from Kasauli has shown that they are also practically identical with the strains occurring in England. From the Delhi strains, therefore, a vaccine was prepared which was submitted to thorough tests on volunteers for local and general reactions and on experimental animal for toxicity. On the satisfactory completion of these tests the vaccine was prepared on a large scale and has now been available to the public for more than 3 months.

As the full value of such a vaccine could only be assessed after extended trial the Government of India decided that up to November 1934 it should be a free issue from the Central Research Institute, Kasauli, in order to popularise its use. Up to the time of writing 26,518 c.c. have been issued.

INDICATIONS FOR USE OF THE VACCINE.

It should be emphasised that the vaccine is purely a prophylactic one and is not intended to be used as a curative vaccine.

In a country like India its chief use would appear to be in institutions such as schools, colleges, jails, hospitals, etc., where cases of cerebro-spinal meningitis occur every year. In such institutions its use once a year would, it is hoped, greatly diminish the incidence of cases. In districts, also, where the disease is especially prevalent it might be desirable for all those likely to be exposed to infection to be vaccinated and the same would hold good for the staffs of hospitals which are likely to admit cases for treatment.

It should also be emphasised that the best time to introduce vaccination is not during the height of an epidemic but before its onset in order to prevent its occurrence or at least limit its extent.

## Research Notes.

### An Improved Wire Grating Spectrometer for the far Infra-red.

IN a recent issue of the *Review of Scientific Instruments* (1934, **5**, 237-243), Bowling Barnes describes an improved type of spectrometer for the far Infra-red using a wire grating. The radiation from a strip of a Welsbach mantle heated by a gas flame is rendered parallel by a system of three concave and two Newtonian mirrors and is made to fall on the specially constructed wire grating. The diffracted pencil is then focussed on a radiometer by another system of concave and Newtonian mirrors. In order to avoid either moving the radiometer or rotating the grating, a very ingenious method of selecting particular portions of the spectrum produced by the grating, originally due to Pfund (*J.O.S.A.*, 1932, **22**, 281), is described. This device is a plane mirror which reflects the diffracted pencil on to the system of focussing mirrors. Adjustment of the position of this mirror enables the selection of different angles of diffraction and thus different portions of the spectrum. If the angle between the position of the mirror for reflection of the central image on to the radiometer and any other position is $\theta/2$ the angle of diffraction in the latter case is $\theta$. This angle is measured very accurately in the instrument.

The grating itself, which is of the transmission type, is made by winding uniform wire over two parallel screws mounted in a framework, soldering the windings of the wire to the screws and cutting them away from the back portion. Even orders are absent in such a grating and so the problem of eliminating overlapping spectra reduces itself to diminishing the intensity of the third order sufficiently. A method of doing this is also described. The instrument can be used for infra-red work both by reflection and by transmission by substances, the specimen being substituted for one of the Newtonian mirrors in the collimating system in the one case and placed in between two of these mirrors in the other case. In this instrument, using a 0·4166 mm. grating, lines, the components of which are known to be $1{\cdot}33\nu$ apart, can be resolved and the wave-lengths of sharp lines can be measured to $\pm 0{\cdot}12$ cm.$^{-1}$

S. R. S.

### The Shape of Long Chain Molecules.

THE present ideas of the shape of straight chain molecules in solution are contradictory, and the question is interesting from the point of view of recent measurements of viscosity and streaming double refraction in sols with needle-shaped, spherical, rigid or flexible particles. The long chain molecules on account of the number of links and the more or less free rotation possible about each of them, can assume, besides their stretched form, numerous other shapes which have all nearly the same energy. The shape to be expected on the average is an interesting statistical problem, and Werner Kuhn has treated it as such in *Koll. Zeit.*, July 1934, **68**, 2. A chain of $Z$ links is divided into $n$ segments containing $s$ links each, such that the average direction of each segment is independent of the preceding one. Such a perfectly irregular arrangement will lead to the shape of a complicated coil, and it is shown that if the individual volumes of the links are neglected, the resulting shape of the irregular coil will be that of a bean, whose rates of length to breadth to thickness is 6 : 2.3 : 1, and the volume will be $\frac{\sqrt{\pi}}{12} b^3 Z^{3/2}$, where $b$ is a measure of the average length of each segment. The value of $b$ is given by $3b^2 = s\, l^2 \frac{1+\cos\beta}{1-\cos\beta}$ where $l$ is the length of each link, and $\beta$ the supplement

of the valency angle. When the velocity of ring formation considered as proportional to the probability of finding the two reacting ends of a chain near each other, is compared with actual observation, the necessity for allowing for the volume of the links is very much evidenced. When due corrections for this volume effect are adopted, the viscosity and other measurements support the bean shape of the chain molecules as against a stretched form. M. A. G.

## A New Type of Phase Advancer.

IN a recent paper (*Proc. Ind. Acad. Sci.*, 1934, **1 A,** 98) J. J. Rudra describes a new type of phase advancer which acts as a combination of expedor and susceptor phase advancers and is suitable for use with large induction motors used as asynchronous condensers. The motor of the phase advancer has a slip ring winding and a commutator winding as in the Schrage motor. The former is supplied with voltage of line frequency through the secondary of an induction regulator. The stator has field and compensating windings as in the Miles Walker phase advancer which are connected through suitable brushes in series with the commutator winding and the slip rings of the asynchronous condenser. The theory of an induction motor connected to this and other phase advancers, and current loci of a 1500 h.p. motor connected to various phase advancers are given.

## Contributions to Our Knowledge of the Cranial Anatomy of South Indian Ranid Genera of Frogs. Part I.

IN an article (*Proc. Indian Acad. Sci.*, 1934, **1**, No. 2, B) certain aspects of the cranial morphology of the South Indian Ranid genera of frogs are described by Mr. L. S. Ramaswami. The author is trying to examine the statement of herpetologists that the genera *Rhacophorus* and *Philautus* could be merged together and also to place the classification of the several species of *Philautus* on a sounder basis by introducing certain cranial characteristics. Among the forms studied *Ph. petersi*,—a native of Siam—seems to be specialised in certain features. The possession of a well ossified cranium, a complete os en ceinture and the co-ossification of the frontoparietals, exoccipitals and prootics in the auditory region where no delimitations are observable, seem to be specific to the foreign species of *Philautus* examined. The presence of the bursa oris angularis in all the forms described is an interesting feature. The bursa had been compared with the tonsils of man by Prof. Fuchs and investigators are not unanimous in accepting Fuchs' view though the gland is definitely shown to be adenoid in nature. The tongue possesses a median papilla in the two South Indian specimens examined, which upsets Boulenger's division of the species of *Philautus* into two groups by lingual characters. Describing the larval habits of Indian *Philautus* the author states that the froth-making habits so common among the foreign forms are not observed in the Indian *Philautus* thereby differing from the observations of Prof. Noble. In conclusion the author points out that the investigated species of *Philautus* cannot be merged with *Rhacophorus*.

## Chromosome Studies in Allium; The Meiotic Chromosomes.

T. K. KOSHY (*Journ. Roy. Micros. Soc.*, **54**, Part 2, June 1934) describes two coiled chromonemata in all stages of meiosis in Allium. This condition observed in the last premeiotic mitosis occurs as intertwined threads in the early leptonema of the meiotic phase. The pairing of the chromosomes simultaneously at both ends of the chromosomes is observed till a side by side association is established. A strepsinema is observed during the diplotene stage. Quadruple structures are formed by the close association of the homologous dual chromosomes, the cleavage being completely suppressed in the first meiotic division. Cleavage of the cromonema occurs in the late prophase of the second division, the univalent chromosomes moving apart to the poles of the heterotypic spindle having in them a two-coiled chromonemata. Meiotic chromosomes are similar to somatic chromosomes in their structure and behaviour. Synapsis at heterotypic prophase and suppression of cleavage at the first division effect the genetic requirement of the reduction of chromosomes.

## The Geology of the Sakarsanahalli Area.

AN important paper on the origin and correlation of the metamorphic rocks of the Sakarsanahalli area, Kolar District, by Messrs M. B. Ramachandra Rao (of the Mysore Geological Department) and K. Sripada Rao

(of the Mysore University) has been recently published (Bulletin No. 14 of the Mysore Geological Department, 1934) in which the authors have given a detailed account of the rocks of the area, with special reference to their origin and correlation. The rocks of the area arranged in the order of their relative ages are:—

*The Schists.*

I. Hornblende schist.
 (*a*) Tarurite.
 (*b*) Limestone.

II. Amphibolites.
 (*a*) Hornblendites.
 (*b*) Tremolite-Actinolite schists.
 (*c*) Cummingtonite schists.

*The Gneisses.*
 (*a*) Champion gneiss.
 (*b*) Peninsular gneiss.
 (*c*) Quartz reefs and Quartzite.

*Dolerite.*

The area is largely composed of gneisses with numerous caught-up patches and thin lenticular bands of hornblende schist and amphibolites. The former in many places are intruded by quartz and aplitic veins resulting in a series of metamorphic rocks called "Tarurites". By far the most prevalent and conspicuous change produced is the conversion of the amphiboles into pyroxenes with the development of contact metamorphic minerals like calcite, garnet, rhodonite, scapolite, epidote, zoisite and apatite. Intense calcification and alteration of these Tarurites has yielded manganiferous limestones in places.

The amphibolites are of the nature of hornblendites or tremolite-actinolite schists or cummingtonite schists. The contact metamorphism of the tremolite-actinolite schists in places has given rise to rocks containing sillimanite and cordierite. The cummingtonite schists through metasomatic alterations appear to have yielded ferruginous quartzites in places.

The numerous patches and shreds of hornblende schist, amphibolite, and tarurite must have at one time formed a more or less continuous series but are now much torn up, isolated, and severely disturbed by the later intrusive gneissic granites. There is, however, no doubt regarding their original igneous origin. With regard to the tarurite, limestone, and sillimanite-cordierite rocks of this area, an original sedimentary origin was suggested some time back and an attempt made to correlate them with the Gondite or Kodurite series of Dr. Fermor; but the present studies do not support such an idea. On the other hand, there are ample evidences to show that they are only alterations of the hornblendic rocks by contact metamorphism brought about by acidic intrusions and subsequent metasomatic or meteoric changes.

The paper is fully illustrated with maps, sections, and photographs.

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## The Morphology and the Systematic Position of a New Trematode from the Intestine of the Golden Orfe, *Leuciscus idus*, with a Note on the Classification of the Family, *Allocreadiidæ*.

IN the *Journal of Helminthology* (**XII**, pp. 127-136), Dr. G. S. Thapar and Mr. J. Dayal have described a new Trematode from the golden orfe. The genus is named *Cotylogonoporum* and is characterised by the presence of the genital sucker, the intertesticular position of the lobed ovary, the disposition of the uterine coils and the peculiarities of the oötype complex. The genus under review resembles the genus *Sphærostomum*, a form which was placed by Poche (1925) under the family *Allocreadiidæ* and is therefore placed near it. The authors in the present communication have rightly separated the latter from this family and have further justified the creation of a new family *Sphærostomidæ* for the reception of the two genera *Sphærostomum* and *Cotylogonoporum*. A general discussion on the family *Allocreadiidæ* follows the account of the genus *Cotylogonoporum*. The authors have clearly shown that the presence of the genital sucker in the present case indicates the affinities of the present genus with the members of the family *Heterophyidæ* and further researches may show it to be a transitional form between the two older families of *Allocreadiidæ* and *Heterophyidæ*.

# Recent Developments in Anthropology, Ethnology and Ethnography in India.

By Dr. P. Mitra,
*Department of Anthropology, Calcutta University.*

INDIAN Anthropologists are in deep debt of gratitude to the grand old man of the science in India, Prof. L. K. A. Aiyar, for keeping on record the 'Recent Developments in Anthropology, Ethnology and Ethnography in India' and its publication in *Current Science*, January 1934. When it received the kind notice of the official Anthropologist of the Government of India, it was expected that all lacunæ would be filled up in his communication (published in *Current Science*, May 1934) but as the expectation has not been realised, it was considered desirable to record the following for the sake of completeness of the survey.

*Physical Anthropology.*—Dr. A. C. G. da Silva Correia, author of at least twenty-seven papers since 1900 on the demography, morphology, anthropometry, ethnography and acclimatisation of the Indo-Portuguese Lusos, has been responsible for a considerable amount of brilliant work in recent years, and thanks to his colleagues, the school of Medicine in New Goa has been fast coming into prominence as the centre of researches in Physical Anthropology. Dr. Fracncisco Correa in his "Recueil de quelques faits anatomiques et teratologiques concernant les habitants de l'Inde Portugaise," records the muscular, vascular and nervous anomalies of several Goanese;[1] Dr. Pegado in his "Anthropological Researches of not bony parts, on the living of 175 natives of Portuguese India" (1931)[2] offers valuable information on certain muscles and forearm veins; and Dr. C. Mascarenhas in his "Contribuiçao para o estudo antropológico de Goa"[3] discusses the measurements of twenty Goanese crania. It is refreshing to find that the medical school at New Goa has not confined its physical anthropological studies to the discussions of whether or not we were originally negroid or australoid or mongoloid.

It is surprising to find that the important work on blood-groups in India has not been mentioned in the previous surveys of both Prof. L.K.A.Aiyar and Dr. B. S. Guha. Pandit's[4] researches have considerably added to our knowledge on 'Blood-groups distribution amongst the Todas'. Chaudhuri has been carrying on valuable researches on blood-groups amongst Bengali Kayasthas parts of his results being published as 'Blood-groups and Heredity'.[5] The publication entitled "The distribution of blood-groups in certain races and castes of India" by Malone and Lahiri,[6] deals with the data for Pathans, Baluches, Rajputs, Jats, Khatris and Dravidians. Krishnan and Vareed have studied the "Basal Metabolism of young College Students, men and women of Madras" with Benedict Roth system with rubber flutter valves and Collin's Kymograph attachment.[7] Mukherjee[8] has published a preliminary note on the Basal Metabolism of Bengalees using Douglas bag and Haldane gas analysis apparatus.

*Ethnology.*—The well-known ethnological researches of Datta specially his "Eine Untersuchung der Rassenelemente in Belutschistan, Afghanistan und den Nachbarländern des Hindu-Kusch" and the "Das Indische Kastensystem"[9] deserve special mention as also the works of the workers of the sociological school in Bombay under the direction of Ghurye. Special mention may be made of the well-known work on Hindu Exogamy by Karandiker. In the Assam valley J. K. Bose and others have carried out important researches on the Aimols, Kabui Nagas and Marings and on Dual Organisation and Sorabjit Singh on Meithei Ethnography and juridical ethnology. The name of P. C. Biswas who recently proceeded to Berlin as Humboldt Fellow, may also be mentioned in this connection; he has contributed to the International Anthropological Congress, papers dealing with "the Primitive concepts of disease in India" and on Santal Ethnography. J. K. Gan has carried out valuable comparative cultural studies in India and Africa[10] and is now engaged on craniometric and anthropometric studies under Chatterji, who, it may be mentioned, has recently discovered important correlations between the vital capacity, height and weight amongst the data for thousands of Bengalees.

Amongst those that have largely contributed to the growth of Indian Anthropology, mention must be made of Crooke. His book entitled "Tribes and Castes of North-Western Provinces and Oudh" was published in 1896, in four volumes. Thurston's "Tribes and Castes of Southern India" (1909), Russell and Hira Lall's "Tribes and Castes of Central Provinces" (1916), Enthoven's "Tribes and Castes of Bombay" (1920-22), Waddel's "Tribes of the Brahmaputra Valley,"[11] Gurdon's "Khasis" (1914), Playfair's "Garos" (1909), Hodson's "Naga Tribes of Manipur" (1911), Shakespeare's "Lushei-Kuki Clans" (1912), Rivers' "Todas" (1906), Shaw's "Thadou Kukis"[12] and Parry's "Lakhers" have always been considered as classical works in the subject. The monumental work of the great European palethnologist Prof. V. Giuffrida-Ruggeri who did pioneer work in "the Systematic Anthropology of Asia" was largely responsible for establishing the conclusions of Rai Bahadur R. P. Chanda's theory of Alpine

1-3 *Arq. Esc. Med. Cir. Nova Goa*, Ser. A., No. 7, pp. 1293—1365.

4 *Ind. J. Med. Res.*, **21**, No. 3, January.

5 *Ind. Med. Gaz.*, April, 1931, **66**, No. 4, pp. 193—195.

6 Malone and Lahiri, *Ind. J. Med. Res.*, **16**, pp. 963—968.

7 *Ind. J. Med. Res.*, 1932, **19**, pp. 831—858.

8 *Calcutta Med. J.*, **20**, 425; also Mukherji and Gupta, *Ind. J. Med. Res.*, 1931, **18**.

9 *Anthropos*, 1927, Band **22**, pp. 142—159.

10 *Man in India*, **13**, No. 1, pp. 17—54.

11 *J. Asiatic Soc. Bengal*, 1901, **69**, Pt. 3.

12 *Jour. and Proc. Asia. Soc. Bengal*, N.S. 1928, **24**, No. 1, pp. 1—175.

element in Indian population—a conclusion which we learn is going to be produced anew by the irksome labour in anthropometry in the last census. Sir William Turner and Sir W. H. Flower did pioneer work in Indian Craniometry and Osteology. For the sake of completeness mention may be made of the following :—Sullivan, for his work on "Andamanese Skulls",[13] Duckworth "Note on the Skull of an Andaman Islander", Zuckermann and Elliot Smith, "Researches on the Aditannallur Skulls",[14] Charles, "On Punjab Craniology",[15] and Tildesley, "Burmese Craniology".[16]

[13] *Anthropological Papers of Amer. Museum of Nat. History*, 1921, **23**, Part IV, pp. 175—201.

[14] *Bull. of the Madras Govt. Museum*, 1930.

[15] *J. Anat. and Phys.*, 1907, **27**.

[16] *Biometrika*, 1921, **13**, pp. 176—262.

# The Agricultural Basis of Religion in India.*

THE religious beliefs and practices in India have received greater attention than any other branch of Indian Culture. The studies attempted so far have preceded either on a comparative or a philosophical basis. But in the study of the primitive and other forms of religion in India, it would appear that fruitful results may be obtained by approaching it from a different angle : namely, by a study of the influences of environment. It seems to me that an examination of the predisposing influences is bound to throw light on the religious practices and beliefs and enable us to interpret properly the anthropological data with accuracy.

I have taken for the theme of my paper "The Agricultural Basis of Religion". Lest the title mislead the reader, I should explain that the circumstances under which agriculture is being carried on in India have exerted an influence on the religious practices of the agricultural castes. The fact that they are widespread and are followed by a large proportion of the people will be evident from the fact that India is essentially an agricultural country and this occupation affords employment to more than three-quarters of the population. As satisfaction of material wants is the chief aim of man, primitive or civilised, the influences which contribute to the success in his efforts also react on his mental outlook. Agricultural operations, whether in Northern or Southern India, are largely determined by the monsoon. The outbreak of the monsoon at the proper time ensures a successful agricultural season, overflowing granaries and provision of sufficient means to the people ; whereas a failure of the monsoon spells economic disaster. As the monsoon is the outcome of the uncertain forces of nature, the agricultural castes find themselves absolutely at the mercy of these influences. It is, therefore, not unnatural that this should produce a spirit of fatalism. Again the fact that land is the chief thing that determines the material welfare of the people is the main reason why so much of ritual, magic and religion is associated with "Mother Earth". The extent to which these two have influenced the religious beliefs, practices and attitude of a large propotion of the agricultural castes in India will be clear from a consideration of the agricultural calendar and ceremonies connected with this occupation.

The agricultural year in South India, especially in Malabar, Cochin and Travancore, begins with *Vishu* or Chaitra Sankranti, which is the astronomical New Year's Day on which the hot weather is supposed to terminate. The sight of the food-stuffs and silver or gold arranged in a bell-metal tray on the morning of the auspicious day is calculated to bring on prosperity during the ensuing year. It is also a day for ancestor worship and worship of the deities in the village temples for the blessings of prosperity. The village astrologer by his calculations announces the agricultural prospects of the year and forecasts the amount of rainfall at regular intervals, the names of the crops that are likely to thrive well, and the famines or epidemics that are likely to break out. Each member of the village consults the astrologer who by the examination of his horoscope predicts his good luck or otherwise during the ensuing year. The same prosperity or ill-luck is determined by the omens arising from the breaking of cocoanuts, and the direction of its rolling on the floor on the morning of the first day of the agricultural year.

The village astrologer next chooses a special day for ploughing and sowing. The seeds are taken in leafy cups, and placed in a basket, and are consecrated. The plough and other agricultural instruments and the oxen are worshipped. They are next taken out in procession to the field. The headman leads by starting to plough and the others follow. Sowing is regarded as a general crisis, a "Rite de passage", and the chief assumes the risk of performing an act full of mystical danger and of uncertain outcome. It is thus a solemn act and is done with prayers to ancestors who are invoked for the prosperity of the crop. When the crops are grown up, the Siddi-Devaru is worshipped with offerings to avert insect pests. The fields and crops are placed under the protection of the village deity, after the offerings to the deities and after Hasta Pongalu during the Hasta rains.

When the crops are fully ripe, there is a special ceremony for bringing them to the family. The house is white-washed and decorated with drawings of rice flour mixed in water. The ground in front of the house is purified with cow-dung mixed with water, and decorated with seven kinds of leaves. The God Ganesa is propitiated and adored. The ears of corn are stuck to the wall with cow-dung. This is followed by a formal cooking of rice obtained from the newly cropped

*Summary of a paper by Rao Bahadur L. K. Ananthakrishna Iyer, read before the First International Congress of Anthropological and Ethnological Sciences, London, 1934.

paddy, which is a survival of the Vedic ceremony of Agrâyana.

The ceremony next in importance is the worship of the agricultural implements on the Vijayadasami day, during the Dasara of South India. This corresponds to the Viswakarma day in Bengal. There are also special forms of worship before harvest. At the time of reaping the sickle God is worshipped. A handful of the crop is then cut and placed in the central part of the field, and near it five stones are placed. The sickles of all the reapers are collected and deposited in a row in front of these stones. They are all worshipped with the breaking of cocoanuts and the burning of incense. The ears of the corn are safely preserved at home and the grain obtained from them is mixed with the seed grain during the ensuing year. Before the grain is removed in carts or head-loads from the fields to the threshing floor, a cocoanut is broken and incense burned. When the threshing is done and the grain heaped together a similar offering is made to the *pillari*. It is also the universal custom that, before measuring, a small portion of grain is set apart for distribution to the poor villagers who may chance to go there.

There is also a similar ceremony at the end of Magh or Makaram, when the crops have been harvested, the agricultural operations have come to an end, and Mother Earth is supposed to take some rest or remain in a state of incubation. At the beginning of this period, the agricultural castes of Malabar observe a festival in honour of Mother Earth which is like the Roman Februria supposed to take place at the same time. It is believed that on the last day of the festival all agricultural leases connected with the land are supposed to expire. In some of the villages of the Walluvanad Taluk of Malabar, special festivals are celebrated with straw models taken out in procession to the Bhagawati Temples.

After the harvest the farmers and others in the villages find their granaries full. It is during this part of the year that all the village festivals are celebrated in honour of the Gods as thanks offerings with prayers for similar harvests in the following year.

## Research in Irrigation.

THE Fourth Annual Meeting of the Research Committee of the Central Board of Irrigation was held in Simla on the 19th and 20th July, 1934. Officers from the following Provinces were present:—Bombay, Sind, United Provinces, Punjab, Bengal, Madras and North-West Frontier. The Meeting of these Officers is of considerable value as it leads to the co-ordination of research work, the exchange of views with a consequent development of new lines of research, and affords an opportunity for the discussion of the particular problems with which each Officer has to deal.

The Agenda for the Meeting included: (i) a discussion of the research work carried out during the year in each Province, (ii) reports on the progress made on a number of investigations, and (iii) the consideration of investigations started during the previous year. As irrigation is of such great importance to the whole of India, a brief summary of the Proceedings may be of interest.

The reports on the work done showed the importance now attached to model experiments. In Bombay, models were used to determine methods for the exclusion of silt from canals and to determine the coefficient of discharge of the Sukkur Barrage Gates. The models studied in Sind had reference to the number and position of the vanes to give a suitable distribution of velocities over the normal section of the channel below flumed falls and regulators, to the coefficient of discharge of radial gates and to the determination of the modifications necessary to eliminate heavy action downstream of a syphon. The report of the Irrigation Research Institute, Lahore, showed that two types of experiments on models were being carried out. The first type dealt with the protection of the downstream glacis of weirs. A system of protection depending upon the throwing of the high velocity water to the surface has been evolved. This form of protection reduces scour to a minimum, and hence will reduce considerably the cost of maintenance of head-works. The second type of work on models deals with the flow of water under works and the pressures involved. Some reference has already been made to this subject in this Journal (Vol. II, April 1934, No. 10). The recent developments are connected with the determination of the effect of an upstream sheet pile on the pressures on the work. The Central Board of Irrigation has now agreed that no major work should be constructed without first being studied in model form.

An important discussion took place on the seepage losses from canals, distributaries and water-courses. Observations made in the United Provinces showed that the major losses occurred in the water-courses and distributaries. The complementary subject of linings was also discussed. The conclusion reached was that lining was not a feasible method of dealing with the losses on large channels which had already been constructed, but that the lining of distributaries and minors was a practical proposition. As the greatest losses occur on these latter types of channels it was agreed that any scheme for lining would be best commenced from the minors.

Considerable attention has been devoted by the Research Officer, Sind, to the study of waterlogging and drainage. The Research Division has a most elaborate system for studying the variation of the level of the sub-soil water-table. The results reveal a rise of water-table in certain areas and indicate that measures will have to be taken at no distant date to control the rise. Before any irrigation scheme is contemplated in future, the example of Sind in this respect should be followed.

In the Punjab the effect of rainfall and irrigation on the water-table has been studied in the areas commanded by the Upper Chenab Canal and Upper Jhelum Canal. It has been shown that there is a high correlation between the movement of the water-table in these areas and the amount of monsoon rainfall. As a result the Government

led to develop the drainage in the ɩreas of the Punjab during a period of .

Punjab the progress on the study of oils is reported. These investigations ɩ conducted in connection with three blems:—(1) The prevention of land ion under irrigation. (2) The study of mation. (3) The quality of irrigation

· known as "Degree of Alkalisation" of s been a subject of study during the year. n shown that crop yield in the plains of b decreases as the "Degree of Alkalisa-eases. It has further been shown that ely small proportion of calcium in an prevent alkalisation of the soil asso-h the presence of the sodium salt. The n conditions for a system "sodium salt salt—calcium sodium clay" have been ad the results are now being applied tally in the field. These results also nportant application in determining the irrigation water that can be safely used oil deterioration taking place. It has n that water containing above 60 parts O of sodium salts in solution results in ange and hence the soil deterioration. ice of a small amount of calcium salt in vater can prevent this reaction. The irrigation water is a subject of special e in the Punjab at the present time as have been made for a development of by means of tube-wells following on the ion of the Province.

Considerable discussion took place on the silt and flow theories which have been put forward by Mr. Lacey. While some of his formulæ were accepted others that had been tested both in the Punjab and in Sind showed that they did not, in their present form, apply to the channels in these Provinces. It was agreed that the formulæ were useful in connection with the remodelling of channels. Extensive studies have been made in the Punjab and in Sind to determine the relation that exists between the bed silt in the channel and hydraulic data of the channel. Two types of siltometers have been developed at the Irrigation Research Institute at Lahore and they are proving of great value in studying the characteristics of silt. The work done at Lahore has shown that the Distribution Curves for the bed silt in a silted, a scouring, and a stable channel have typical forms. A number which can describe a silt and which is a function of the weighted mean diameter of the silt particles is now being studied in connection with the hydraulic data of channels with the object of determining whether any relation between the silt and the hydraulic data exists. Results of these investigations will probably have an important influence on the design of channels and on cost of maintenance of channels already in existence.

At the conclusion of the discussion of the Agenda the Research Officer of Madras drew attention to the growth of weeds in channels in his Province, a subject which also appeared to be of considerable importance in Bengal. A solution of the problem would be of considerable economic value and the subject deserves intensive study.

# The Chemistry of Milk.

ıe important discussions organised by Chemistry (B) and Agriculture (M) the British Association for the Advance-ience at their last session was on "The of Milk".

ıer contributed a paper on the *Compo-Iilk and the Present Regulations.* The s of the constituents of milk are known dely from sample to sample even in the ked milk. In the case of fat and solids centages, it is known that many cases here the values fell below the prescribed ve limits under the regulations. Several ıre known where *genuine* milk has been watered. Various workers have found eezing point of milk is the least variable ical characters, the coefficient of vari-g approximately 1·5 as against 4·5 for index and 5·0 for specific gravity. On its low variability the freezing point of een frequently used as a criterion for ".

ourse of his paper on the *Chemical Com-Abnormal Milk*, Dr. Dabies said: "Abnor-buffer value in the acid range, in the acidic and basic constituents, in the n of ionic acid and non-ionic metallic a), in the amounts of the various forms resent and in the amount of heat-coagul-in, is reflected by abnormality in ren-'curd tension' and in heat stability at res above 100°C.

Dr. Linderstrom-Lang contributed an interesting paper on *Some Chemical and Physical Properties of Casein.* "Casein (caseinogen), the phosphor protein in milk, is a mixture of two or more substances. By treatment with acid alcohol it may be divided into several fractions that duffer in chemical composition, especially in their content of phosphorus. Mixing the fractions in their original proportions gives the original casein with its characteristic physical and chemical properties.

Investigations of the solubility of casein in acids and bases show its complex nature. The solubility is, under constant conditions, a function of the amount of casein present as precipitate, and the dissolved substances differ in chemical compositions from the precipitate.

The fact that casein is a mixture makes investigations of its chemical structure difficult. Due to its high content of phosphorus and the importance of this to nutrition problems, the mode of combination of this element has been the subject for elaborate studies. Experiments show that the phosphorus in casein is present as phosphoric acid and—at least partly—bound to serine by an ester linkage. As the phosphorus content of the different fractions of casein is different, this problem is of importance to the explanation of the above-named physical properities.

Other papers that came up for discussion were *The Composition of Milk Fat* by Prof. T. P. Hilditch and *The Vitamins of Milk* by Dr. S. K. Kon.

## Science Notes.

*The Central College Mathematical Society.*—This Society whose primary object is "to stimulate and encourage the study of, and research in, the field of contemporary mathematics", was recently inaugurated at Bangalore. The programme of the Society includes monthly meetings for the reading of original papers and weekly discussions on selected topics, the discussion being initiated by a member who has made an intensive study of the subject. It is also proposed to hold special discussions from time to time on problems of mathematical interest. The organisers welcome co-operation from all those interested in mathematics.

The inaugural address of the Central College Mathematical Society was delivered by Prof. K. S. K. Iyengar on the 3rd September 1934, Prof. B. Venkatesachar presiding. "Mathematical Philosophy" formed the subject of the address.

In the course of the address Prof. K. S. K. Iyengar pointed out that all arguments based on our experience show that they depend upon two important elements for their validity, sense data and certain general principles forming a group of intuitive truths, that is, they belong to the *a priori* aspect of our knowledge and cannot be proved or disproved although we come to realise their truth by experience. The elements of the *a priori* knowledge are called universals which in ordinary language mean qualities and relations. Whether universals and a knowledge of their relations being not empirical, are purely mental is a very important question. To assert that they are purely mental would lead one to great difficulties (Kantean doctrine) in the theory of knowledge. This difficulty is solved in Indian Philosophy by the assumption of an unchanging Universal Mind (*Mahat*) of which our minds are in some way parts.

The Professor then passed on to a detailed examination of the elements and methods of procedure in mathematics, stressing on the importance on the serial order. The fruitfulness of a critical examination of postulate systems with special reference to geometry, was pointed out.

"I may say that the essence of mathematical procedure is the postulation method and hence rigour is of the utmost importance in mathematics. Whenever anyone asks us whether mathematics deals with truth, we can only reply to him that we are all concerned here in drawing implications of a set of assumptions and there our business ends. No doubt we construct, out of our Universals, all possible worlds, but we do not know whether such worlds exist in the ordinary sense of the word in which I may say that we exist. True research of a high order in mathematics is in building up of such synthetic structures of relational Universals. Some of these structures may be of use some time later, in building up the theories of experimental sciences as, for example, the theory of groups and matrices has proved to be, in modern quantum mechanics." He concluded with a very appropriate quotation from Lord Russell that pure mathematics (or logic which is the same thing) aims at being true in the true Leibnitzian phraseology in all possible worlds and not merely in this higgedly-piggedly job lot of a world in which Chance has imprisoned us.

* * *

*Twenty-ninth Half-Yearly Meeting of the Indian Central Cotton Committee.*—The meeting was held on the 28th and 29th August with Diwan Bahadur Sir T. Vijayaraghavacharya, Vice-Chairman of the Imperial Council of Agricultural Research, in the Chair. Among the important subjects that came up for discussion, were (1) the immediate need for legislative measures to rid the cotton industry of the prevailing malpractices of watering and mixing of cotton which were widely condemned by leading cotton merchants and firms in Bombay; (2) the cultivation of improved varieties of cotton in the Barrage areas of Sind; (3) the campaign for extension, seed distribution and marketing of pure Sind-American Cotton; (4) and the future policy to be adopted in the case of the Institute of Plant Industry.

* * *

*Asiatic Society of Bengal.*—An ordinary meeting was held on Monday, 3rd September. Several valuable exhibits were shown and commented upon. Among them may be mentioned:—(1) Exhibition of four specimens of Deccan trap Basalts and Dolerites from the Chhindwara District, Central Provinces, by Dr. L. L. Fermor, (2) The Bahjoi Meteoric Iron, by Dr. M. S. Krishnan, (3) The Khanpore Meteorite by Dr. M. S. Krishnan, (4) Photographs of sun-shades for fishes, by Dr. S. L. Hora, (5) Three small Bronzes from West Africa, by Dr. S. K. Chatterjee, and (6) Three China Plates representing the three famous Buddhist Pilgrims, by Mr. Johan van Manen.

A course of four lectures by eminent scientists of the country were arranged under the auspices of the Society, at Calcutta during August and September. They were designed to convey instructive and interesting information in attractive form to a general cultured audience not necessarily composed of specialists.

(1) Trade in Live Fish (*Jiol Machh*) in Calcutta, by Dr. S. L. Hora (31-8-1934):—A great volume of trade in live fish has been built up in Calcutta which annually receives over 50,000 maunds of this article of food from the outlying deltaic stations. Fish is generally popular among the major sections of population in Bengal and if live fish can be obtained, there must naturally be a great demand for them on account of their greater flavour and nutritive qualities.

The consignment produced in the market represents a group of animals belonging to different families and their transportation to Calcutta from various mofussil centres is rendered possible by their capacity to breathe atmospheric air as well as water. They can be easily carried in large numbers in suitable cases in a live state. Dr. Hora dwelt at length on old methods of distributing the fish and described the present-day means. He drew attention to the several ways in which the imported fish and the local produce are distributed and in passing, touched on the culinary processes of preparing these articles for the table. Reference was made to the trade statistics together with remarks on the social and economic

conditions of the people engaged in this traffic. The periodic fluctuations in the trade which must necessarily affect both the consumer and the producer are accounted for by investigations into the general and seasonal habits of the fish.

Dr. Hora has offered practical suggestions for improving the quality of the fish offered for sale, which must be beneficial both to the consumer and the tradesman. Generally the live fish produced for sale in the Calcutta markets, go involuntarily on hunger strike tending to great slimming thereby impoverishing their nutritional value. One of the suggestions made by Dr. Hora for the preservation of fish in their proper condition till the time of disposal, is to investigate the natural food of the fishes and prepare nearly the same food or a good substitute on which they could be fed during the period of captivity.

(2) The North Bihar Earthquake of the 15th January 1934, by Mr. J. B. Auden (7-9-1934):—The lecture summarises the results of an investigation in the field of Mr. Wadia, Dr. Dunn, Mr. Ghosh, and the lecturer. The description of the severe damage caused by the earthquake regards two main zones: firstly, the central zone represented by the epicentral tract and the slump belt; secondly, the bordering Patna-Monghyr belt and the Valley of Nepal. A brief discussion of the more general effects of the earthquake, such as emission of sand and water, landslides, etc., is followed by an account of the possible causes, comparison being made with other recent Indian earthquakes. Finally, the lecture ends by discussing the time of the earthquake as deduced by seismographic records, and the question of future immunity in Bihar.

(3) The Fundamental Constituents of Matter by Dr. Meghnad Saha (15-9-1934):—The lecture will describe discoveries of the Electrons and the recent discoveries of the Positrons and the Neutrons. It will also deal with the probable existence of other probable fundamental particles as Dirac's Free Magnetic Poles and the probable effect of their existence on our views regarding the electro-magnetic origin of mass. The lecture will also deal with the nature of cosmic rays, the probable existence of a world of anti-atoms, and also certain other cosmological problems of fundamental importance.

(4) The Shan Hinterland: the country and its people, by Dr. M. R. Sahni (21-9-1934):—The speaker will give a talk on the prolific and amazing variety of tribes inhabiting the Shan States of Burma and deal briefly with their geographical distribution, their more interesting customs and traditions.

* * *

Mr. D. Narayanamurti, M.Sc., A.I.C., A.I.I.Sc., A.Inst.P., of the Forest Research Institute, Dehra Dun, has been awarded a scholarship by the Deutsche Akademie. Mr. Narayanamurti will be sailing for Germany from Bombay on the 8th October. During his stay he proposes to devote most of his time to research on the seasoning of timber and to the study of X-ray technique as applied to the study of the properties of fibrous materials.

* * *

Mr. V. Ramanjalu Naidu, Temporary Demonstrator in Physiology of the Medical College, Mysore, and a Medical Graduate of the Mysore University, has been awarded the Fellowship in Pathology by the Mayo Foundation, Rochester, U. S. A. He sailed for America *via* England on the 18th August 1934.

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We understand that Mr. G. B. Patel, a cotton breeder of Gujerat, has been granted a scholarship by the Central Cotton Committee for training in cotton breeding in U. S. A., for 2 years.

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Dr. D. R. Sethi has been confirmed as Director of Agriculture, Bihar and Orissa, in succession to Mr. G. S. Henderson.

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Dr. MacLagan Gorrie, D.Sc., I.F.S., of the Forest Research Institute, Dehra Dun, has been awarded the Leverhulme Fellowship, 1934, for carrying out researches on "The Correlation of Erosion Damage and Grazing in Forests".

* * *

The Academic Council of the Muslim University has conferred its first Ph.D. Degree on Mr. Omar Farooq for a thesis entitled "The Directive Effect of Substituents on the Thiazole Cyclisation of S-Diarylthio carbamides by Bromine".

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The Cauvery-Mettur Project was inaugurated by His Excellency Sir George Stanley on 21st August. The scheme consists of a dam which is the largest in the world and which forms a reservoir to store the flood waters of the Cauvery and supply water to the delta as and when necessary. The reservoir, besides benefitting the ryots of the Tanjore District by ensuring a steady supply of water, provides for the irrigation of a new area of 301,000 acres in the Tanjore District.

* * *

*University of Mysore.*—The Seventeenth Convocation of the University of Mysore, for conferring degrees, will be held in the Pavilion, Jaganmohan Palace, Mysore, on Wednesday, the 31st October 1934, at 9 a.m.

Admission to the Convocation Hall will be by tickets and intending visitors should apply previously in writing to the Registrar, University of Mysore, Mysore, for the tickets, giving name and occupation. No ticket will be issued for school children. In view of the very limited accommodation available, applications made by any one for more than one Visitor's Ticket cannot be complied with.

Candidates for degrees desirous of bringing a guest, should apply for tickets previously, giving name and occupation of guest. Applications will be complied with to the extent of accommodation available and not more than one guest ticket will be given to any one candidate. Applications should be made before the 15th October 1934.

* * *

*Cotton Breeding in Madras.*—The Madras Herbaceum Scheme financed by the Central Cotton Committee, has for its objective the evolving of a strain possessing the yield, ginning and spinning qualities of Karunganni, *Gossypium indicum* and the colour and root system of Uppam *Gossypium herbaceum*. Whereas the former yields and gins higher its lint is not so white as that of Uppam and thrives well only in years of good rainfall, the latter type grows even in years of moderate drought. The farmer generally grows the two cottons together as an insurance against a bad season but the inevitable indiscriminate mixing lowers the value of a fine cotton.

The research was started in 1923 and during the first few years attention was concentrated on the isolation of pure lines. Hybridization work is now in progress and although several interesting results have been obtained, it is too early to give a definite verdict on the success or otherwise of the investigation.

* * *

A copy of *Marriage Hygiene*, a new journal devoted to a scientific exposition of sex problems, has been sent to us. Edited by a board of eminent medical men of Bombay the magazine contains contributions from Havelock Ellis, Marie Stopes, Julian Huxley and other eminent scientists who have devoted their energies to educating public opinion concerning sex and sex problems. The Journal is printed by the Times of India Press, Bombay, and the get-up is neat and attractive. It is a welcome addition to Indian Scientific journalism and we wish it a career of usefulness.

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*Mechanical Properties of Bricks and Brickwork Masonry.* (Building Research Special Report No. 22. H. M. Stationery Office, Price, 1s. 5d. Post free.)

This special Report describes an investigation which was carried out with the object of collecting information on the mechanical properties of typical bricks and brickwork in use in Great Britain. It was deemed particularly necessary as no authoritative work on the subject has been published since 1905. The test results covering a wide range are collected together in a series of valuable tables. Data on other physical properties are given in an appendix to the report.

* * *

*Abnormal Development of the Radicle in Mango.*—Mr. Tarachand Nandi, Bangabasi College, Calcutta, writes; "The germination of the mango ordinarily takes place by the bursting of the hard endocarp and the radicle comes out through it on having sufficient moisture and other necessary conditions of germination but in the specimen under consideration, while the mango was still a perfect fruit with epicarp, mesocarp and endocarp, the development of the radicle has considerably progressed. The fruit was perfectly ripe and on the removal of the epicarp and fleshy mesocarp, the radicle was seen to have developed to 3·6 inches and the endocarp showed slight bifurcation.

The probable explanation is sought by the writer to be unfavourable condition of the soil. Such a form of germination is known in the case of viviparous mode of plant-life.

"The hard endocarp is 4·8 inches long and 2·5 inches broad and is popularly known by the name of Fuzli variety of mango; whether it should be explained as viviparous or not requires further investigation. The specimen has been preserved in the Biological Laboratory of the Bangabasi College, Calcutta."

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*Aerial Roots in Vitis quadrangularis, Wall.*—Mr. S. A. Parandekar, M.Sc., of the Biology Department, Rajaram College, Kolhapur, writes: "An interesting phenomenon of the presence of aerial hanging roots as those in Banyan (*Ficus benghalensis*, Linn.) has been observed in *Vitis quadrangularis*, Wall.

"The plant is being trained on a greenhouse, along with a few others, *e.g.*, Ipomea, Dioscorea, etc. It has gone on the top of the structure (12 ft. high) and spread up extensively; from there it gives off a number of adventitious hanging roots, reminding one of the Banyan plant so commonly met with. A few of such roots are also given off from the lower portions of the plant and they have already entered the soil.

"The plant is known for its quadrangular simpodial stem with stem-tendrils which are leaf-opposed. Now it is found that the adventitious roots mentioned above arise at the nodes from any of its sides which are not occupied by the tendril or the leaf, as shown in the accompanying diagram. A reference to the relevant literature at hand, however, fails to cite the phenomenon; it is thought proper, therefore, to record it as the same might prove of interest to many."

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*A Statistical Study of the Maximum Temperatures at Poona* (*R. J. Kalamkar*).—This paper deals with the analysis of Maximum Temperature at Poona from 1880 to 1931. The coefficient of variability of mean monthly maximum temperature is comparatively higher for June and October which are characterised by the setting in and withdrawal respectively of the south-west monsoon. The values of the correlation coefficients for the neighbouring months of autumn and winter are high. Regression equations for forecasting temperatures for the five seven-day periods, *viz.*, November 27—December 3rd, December 4th—December 10th, December 11th—December 17th, December 18th—December 24th and December 25th—December 31st, are obtained from the weekly temperatures of the preceding four weeks.

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We acknowledge with thanks the receipt of the following:—

"Actualites Scientifiques et Industrielles," Nos. 109, 113, 115, 116, 119, 133, 135, 136, 141, 147, 150, 155, 157, 158, 162.

"Journal of Agricultural Research," Vol. 48, Nos. 7–10.

"Memoirs of the University of Cambridge School of Agriculture," No. 6.

"Journal of Agriculture and Livestock in India," Vol. 4, Pt. 4.

"Indian Journal of Agricultural Science," Vol. 4, Pt. 3 and Index to Vol. 2, 1932.

"Biochemical Journal," Vol. 28, No. 3.

"American Journal of Botany," Vol. 21, No. 7.

"Canadian Journal of Research," Vol. 2, No. 1 and Vol. 10, Jan. to June 1934, Index.

"Chemical Age," Vol. 31, Nos. 785—790.

"Berichte der Deutschen Chemischen Gessellschaft," Vol. 67, No. 8.

"Journal of the Indian Chemical Society," Vol. 11, No. 6.

"Experimental Station Record," Vol. 70, No. 6; Vol. 71, No. 1.

"Educational India," Vol. 1, No. 2.

"Indian Forester," Vol. 60, Nos. 8 and 9.

"Forschungen und Fortschritte," Jahrgang 10, 20/21, 22, 23/24.

"Indian Forest Records," Vol. 20, Pts. 7, 8 and 9.

"The Quarterly Journal of the Geological Mining and Metallurgical Society of India," Vol. 5, No. 4; Vol. 6, Nos. 1 and 2.

"Transactions of the Mining and Geological Institute of India," Vol. 29, Pt. 2.

"Monthly Statistics of the production of certain selected Industries of India", April, May and

June 1934. Government of India Publications, Nos. 1, 2 and 3 of 1934–35.

"Medico-Surgical Suggestions," Vol. 3, Nos. 7 and 8.

"Journal of the Indian Mathematical Society," Jubilee Commemoration Volume 20.

"Nature," Nos. 3376–3381 and Index to Vol. 133 Jan.—June 1934.

"Journal of Nutrition," Vol. 8, Nos. 1 and 2.

"The Journal of Chemical Physics," Vol. 2, No. 7.

"Journal de Chemie Physique," Tome 31, Nos. 6 and 7.

"Indian Journal of Physics," Vol. 8, Pts. 5 and 6.

"Review of the Scientific Instruments," Vol. 5, No. 7.

"The Indian Trade Journal," Vol. CXIV, Nos. 1466–1472.

## Forthcoming Events.

*Society of Biological Chemists, India.*—The following papers will be presented during September and October:-(1) 28-9-1934. Mr. R. H. Ramachandra Rao, M.Sc., "The Influence of Aeration in the Diastatic Activity of Steeped Barley" at the *Indian Institute of Science, Bangalore.* (2) 5-10-1934. Mr. B. H. Krishna, M.Sc., A.I.C., "Colloidal Medicaments" at the *Central College, Bangalore.*

## Reviews.

"THE SILVER JUBILEE COMMEMORATION VOLUME" of the Indian Mathematical Society.

The Indian Mathematical Society celebrated its Silver Jubilee in December 1932 at Bombay. The twentieth volume of the *Journal of the Society* is published as the Commemoration Volume. The volume contains a report on the progress of the Society during these twenty-five years. It also contains a number of interesting papers contributed by Indian scholars and well-wishers of the Society, on various subjects in Mathematics.

Prof. Watson contributes a paper on the proofs of certain identities in combinatory analysis which are connected with the famous Roger-Ramanujan identities in combinatory analysis. The author uses Ramanujan's notations in the course of the proof. S. S. Pillay has determined the true order of the sum-function of the number of prime factors of $n$ and another allied function with and without the Riemannian hypothesis. E. H. Neville contributes a big paper on 'Iteratine interpolation". E. T. Bell has contributed a paper on an algebra of numerical compositions. S. M. Shaw has determined upper and lower bounds of $\frac{A(n)}{n}$ in a closer manner than Behrend where $A(n)$ denotes the number of abundant numbers less than $n$. G. A. Miller has constructed an infinite system of groups possessing certain given properties and has shown every group possessing certain properties can be extended to a group belonging to the infinite system. K. Ananda Rao has studied some more properties of the elliptic modular function in the neighbourhood of its line of singularities. C. N. Sreenivasaiengar has contributed a paper on the singular solutions of ordinary differential equations of second order. K. Venkatachaliengar has given a simple general method of constructing series whose terms and sum-functions are continuous in an interval and which converges non-uniformly in every sub-interval. S. Chowla has obtained the orders of certain expressions which occur in connection with Waring-Hilbert theorem.

C. V. H. Rao has given a purely projective definition of the $\phi$-Conic. T. Hayashi has solved an ancient Japanese mathematical problem. W. Blaschke has proved that a hexagonal 4-web of surfaces is except for topological transformations uniquely determined by three functions each of one variable. D. D. Kosambi has contributed an interesting paper on "The Problem of Differential Invariants". B. Ramamoorti has given a "Covariant specification of the simplex inscribed in a rational norm curve in a space of odd dimensions and circumscribed to a conic inpolar to the Curve". S. Krishnamoorty Rao has studied how quadrics and subregions in a space of degree $n$ are transformed by a given point collineation. A. A. Krishnaswamy Iyengar has contributed some results in connection with oriented circles. Ram Behari has obtained the condition that the osculating quadric of a skew ruled surface be equilateral and has also obtained a new geometrical meaning for the Laguerre function. G. P. Rao has given a method computing Gravity Anomalies. M. Raziuddin Siddiqi has proved the existence and uniqueness of the solution

of some differential equation which occurs in connection with the equation of heat conduction in wave mechanics. K. Nagabhushanam has contributed a paper on the Transformation Theory of Dynamics in the Manifold of states and time. K. K. Mukherjee has a paper on the Normalisation in Wave Statistics.

The editors should certainly be congratulated on the excellent printing and appearance of the volume.

K. V. I.

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SM QUELQUES PROPERTIES DES POLYNOMES. By J. Dieudonne. (Hermann & Co., Paris. 24 pp.) 6 francs.

This short monograph deals with the applications of the theory of bounded functions to the properties of polynominals all of whose roots are situated within the unit circle. The connection between them was pointed by I. Schur in connection with his solution of the famous coefficient problem of bounded functions. This book is devoted to the study of less profound relations between them which are capable of easy applications to other problems particularly to those concerning the successive derivatives of these polynominals. The author studies various properties of certain polynominals such as the value of their minimum radius of convexity, etc. The constants obtained are the best possible. Some applications of these are indicated at the end of the book.

K. V. I.

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L' ARITHMETIQUE DE L' INFINI. By Maurice Frechet. (Hermann & Co., Paris. 38 pp.) 10 francs.

This book aptly forms the first among the series of books on General Mathematical Analysis which are to be published under the editorial direction of the author. The first thing that one has to study in order to get a complete grasp of analysis is the logical foundation of Infinity. The author has set forth in very lucid terms the definitions of various notions introduced by Cantor, *viz.*, cardinal and ordinal numbers, transfinite numbers. A short account of operations of point sets and the theory of measure are also treated in the book. The author's treatment of the subject is very succinct and brilliant. One great relieving feature about the book is that it does not make use of complicated symbols which are very common in advanced books on real analysis. It is really remarkable that the author has treated the whole subject within a short space of 38 pages. A select bibliography of recent literature on the subject is appended at the end of the book.

K. V. I.

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ELEMENTARY MECHANICS, including Hydrostatics and Pneumatics. By Sir Oliver J. Lodge, D.SC., LL.D., F.R.S. (Chambers Limited, Edinburgh, pp. 308. New Edition. Revised and enlarged). Price 4*s.* 6*d.*

This authoritative and highly useful book on Mechanics was first issued by the author in 1896. It is since revised and enlarged. The present one is a copiously illustrated, new edition of the book.

The author who is the well-known scientist and writer, Sir Oliver Lodge, has designed this book to be a really useful hand-book of Mechanics for students. The following are some of the special features of the book:—(1) It is written in a manner so as to be understood by the student who has not specialised in mathematics and even by the layman, without, at the same time, sacrificing accuracy and precision; (2) The subject-matter is treated in such a way that the Laws of Physics have been deduced from first principles and familiar experience rather than from special experiments; and (3) Finally, it is meant to be an easy introduction to a more thorough study of the subject and at the same time a philosophical work.

The subject-matter is treated in a logical and vivid manner and is intelligible even to the student preparing for various examinations by private study. A large number of graded examples have been added and a number of question papers appended.

The Indian student preparing for the various University Examinations will find this book highly useful. It should be indispensable to all libraries.

The printing and the attractive get-up add to the high quality of the book.

B. V. SASTRY.

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CONTENTS.





## Science and Happiness.

FROM a human standpoint, the concluding portion of Sir James Jeans' presidential address to the British Association is perhaps the most interesting. Within recent times there has been quite a volume of indiscriminate criticism about the benefits of science, and almost all the travail from which the world is suffering is attributed by a section of public opinion to the progress of scientific knowledge in its applications to the practical problems of life. Assuming that there is an element of truth in such an accusation, we are unable to discover a means of escape. Scientific knowledge has now become an integral part of modern culture, and its advancement is bound to be rapid in view of the assured provision for its encouragement, and few can control its direction and output. It is practically useless to suggest the abolition of scientific inventions or to stop scientific researches in any one country, without other countries undertaking similar obligations. Even if such a proposal were feasible, the net result would be to petrify society, but the hopes of restoring to man his happiness and peace the loss of which he is generally in the habit of laying at the door of science, would be as far from realisation as ever. Science has widened our outlook and augmented our store of knowledge; but it has also failed to enrich our moral endowment. It is equally true that scientific industrial planning will displace more labour than it can absorb, and all efforts to establish a balance between labour-saving devices and unemployment are bound to be futile.

We cannot ignore the innate tendency of man to press every kind of knowledge into his service, no matter to what branch of science and art it may belong. To acquire control over the forces of Nature or to perfect the methods of investigating the facts and phenomena of objective reality, is not in itself fatal to the well-being of man; but the end which he uses the scientific knowledge to achieve, makes a wide difference. Knowledge is neither moral nor immoral. It places in our hands the power of dignifying and saving human life; it also puts at our disposal the weapons of destroying it on a scale to which history scarcely furnishes a parallel. If in the past the Church and the State complacently permitted religious differences to lead to bloodshed,

the highly organised modern society need not be shocked when national rivalries, stress of over-population, economic competition and tariff barriers occasionally result in the outbreak of hostilities. The conditions of international relations which generally precede conflicts are the product of scientific development, and the operations on the field when it is taken, pass under scientific management. It is difficult to foresee a time when wars will be totally abolished, though in future they will be less frequent; it is equally difficult to imagine whether any economic planning will produce a permanent and equitable adjustment of labour and capital on the one hand, and, on the other, remove the causes of industrial depression, arising from over-production and from a defective scheme of distribution. The conspicuous feature of the twentieth century is the increasing readiness with which the fruits of scientific labours are utilised for sophisticating the human wants and for gratifying the fundamental appetites of man. The gifts of science have been applied to render social life artificial, and naturally its reactions to the environment must partake of the characteristics of materialism. In moments of intellectual exaltation we are apt to ignore the basic fact that life, whether it manifests itself in an amoeba or man, is under the influence of jealousy which expresses itself in organisms seeking to gratify the appetites of stomach and sex. Centuries of religious and educational progress and the creation of stern public opinion have not succeeded in repressing the imperiousness of this sinister emotion; science is not concerned with disciplining it. It is idle to talk of creating a new Heaven on earth so long as this primitive passion continues to dominate the public and private life of the individual and is a potent factor governing international relations. Science in its manifold applications rather emphasises economic jealousies between highly organised nations and by favouring mass production tends to embitter labour.

There is a great deal of truth in what Sir Alfred Ewing said two years ago as the President of the British Association, *viz.*, "Science has given man control over nature before he has gained control over himself". The function of science in any civilised community is obviously two-fold. It furnishes those who pursue its path with a picture of the physical phenomena of Nature, and the laws under which they manifest themselves, and the direction the extent of their practical service to man. A scientific mind is purely intellectual and virtually ignores the value of other types of experience. The second function of science is to provide helpful guidance to society for consolidating its forces for advancing its higher destiny. In the fulfilment of this latter aspect of its function, the efforts of science are confronted by a play of emotional complexes which form the foundation of all modern states and societies. Political and social organisations can only enjoy the benefits of science conferred indirectly through workshops and industries, but can never hope to apply scientific methods and discipline to their evolution and development. The intellect of man is different from that of child; but his emotions, though restrained more often than those of a child can be, are, however, more sinister and destructive when they break out. The intellectualism of the twentieth century has still a strong background of crude passions and, if in the next stage of the evolution of mind, this background is replaced by moral responsibility for human thoughts and actions to a tribunal not built by man, we shall be pretty near to achieving universal happiness and peace. This is a dream; but it is pleasant to dream.

Science in the pursuit of her enquiry is generally intolerant of sanctity and traditional authority, and she reorganises her statistical and comparative method as the only approach to Truth. This is permissible in respect of values which science discusses objectively, without actually experiencing. But the business of life is higher; it prescribes standards of values which it experiences in its relations towards the universe; the experience is a complex of emotions which does not obey the laws and discipline imposed by the physical sciences. For the advancement of material progress, scientific investigations are indispensable, but for certain other aspects of social life, religious approach is the more important. Human experiences, requirements and ideals can be viewed and interpreted not only from the standpoint of objective sciences but also from that of religion. Their functions are complemental, and the seeming opposition between the two modes of approach to life is due to want of mutual understanding of the deeper significance and purpose of human existence. In a lower sense civilisation is material and in building

t, scientific results lend themselves to be ısed as the means for accomplishing selfish ;ains, and for destroying and constructing he external embellishments of social life. In ts higher aspects, civilisation connotes the nrichment of the moral and spiritual ndowments of man, involving a radical ransformation of his mental attitude owards his fellow-beings. Theology undid vhat religion attempted to achieve in this lirection; but science in giving us a deeper nsight into man's relation to his environnent and knowledge of his origin and ıature, may still become the friend of eligion to assist in the achievement of man's ıighest destiny. The divorce of religion 'rom science has delayed the process of ıumanising the mind and should account 'or the numerous woes from which man suffers. In order that religion, whose progress has been retarded by theological loctrines and ecclesiastical superstitions, night overtake science, the latter is not equired to suspend its activities, but to ıasten slowly. Their co-operation must esult eventually in humanising the mind; ınd the attainment of this object offers the ıope of establishing universal concord and ıappiness.

It is true that civilisation is a term too elastic and impalpable to be defined, but as we understand it, it is synonymous with industrial progress, expansion of trade, multiplication of wants, speedy locomotion, over-population, unemployment problems and fears of invasion. It is pertinent to ask whether this civilisation has tended to enhance our respect for the sanctity of human life and for the rights of personal property; or has it tended to enable those that can afford to provide themselves with material comforts, to enjoy them in peace and security? The gifts of science turn into blessings or curses, in proportion to the humanisation of the mind, dealing with them. The humanised mind intuitively acts upon the standard of absolute values set up by science and religion, for constantly checking the estimates of good and evil in our own nature. The impulses and motives which guide human actions in a world of material civilisation are, with honourable exceptions, dominantly personal, but under the combined influence of science and religion, they are expected to promote universal happiness. This fundamental transformation of the human mind is civilisation in its true and higher sense, and it is a consummation in the attainment of which science and religion have to co-operate for centuries.

It is pedantic to define happiness, but every one who has a healthy body and a clean and benevolent mind which are at peace with one another and with the environment, must have experienced it. Science can make life comfortable though not for all; but life yearns for happiness, now and hereafter. Universal happiness cannot exist so long as public life continues to be disfigured by folly, lust, crime, poverty and squalor, which are the concomitants of material civilisation which has no use for the absolute values of life proclaimed and taught by religion. Religion is opposed to organised ecclesiasticism and theological doctrines which have divided and embittered mankind. The Empire of religion is over the purer and finer emotions of love and joy as they spring from the undefiled heart.

In a society where comforts can be purchased by money, their enjoyment becomes obviously restricted to a few. The wealth which an industrial civilisation produces acquires an artificial power and value. Its drawbacks form the theme of economic science. Is it beyond the wit of man to invent a new type of coinage which will be sufficient for the needs of modern life, and which can neither be hoarded nor melted, possessing at the same time some measure of immunity for resisting the fluctuations to which the existing currency is periodically subject? Gold and beauty have by their rarity been the cause of the world's miseries. If we cease to attach any value to them, their possession will not elevate us and their loss will not depress us.

The new forces of the twentieth century have no relation to the noble traditions of the great historical civilisations. We assume that the multiplication of schools tends to the general refinement of mind, and the increased output of industrial products, to the promotion of happiness. We further assume that ability to invent delicate instruments for scientific research has raised the stature of scientific genius. Science has its own limitations, but in collaboration with humanism, it may some day succeed in producing a combination of circumstances favouring the appearance of new human chromosomes and genes transmitting to the successive generations, those worthy qualities which adorn life and make it happy. This is not a meditation. The

scientific humanism about which we read so frequently in current literature envisages a new civilisation, in which the arts and sciences will be studied "with a genuine devotion to the Good, the True and the Beautiful" and in which the qualitative values of human life and its ideals will not be distorted by industrial progress. Science and human nature are essentially reconcilable. Scientific civilisation ought to produce a change in the attitude and temper of mind radically different from what at the present moment are the dominating motives of individual and corporate action. Human nature being what it is, its transformation must occupy time not easily calculated, but in the meantime the question proposed by Sir James Jeans has to be answered. He asks, "Is it not better to press on in our efforts to secure more wealth and leisure and dignity of life for our own and future generations, even though we risk a glorious failure, rather than accept inglorious failure by perpetuating our present conditions, in which these advantages are the exception rather than the rule?" To strive to enrich the gifts of science is worthy, but to spread their beneficence for the uplift of human nature is nobler.

## The Deccan Traps: Are They Cretaceous or Tertiary?

By B. Sahni, D.SC., SC.D.

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In the history of Science it has sometimes happened that a pioneer, working with a freer mind than it is perhaps possible to keep now-a-days with the influence of a long literature behind us, has arrived at conclusions which have ultimately proved to be sound, although they were long disputed by those who came after him. The object of the present note is to draw attention to what is probably another instance of this kind.

The older geologists Malcolmson,[1] Hislop and Hunter[2] and even T. Oldham[3] as late as 1871 regarded the Deccan Traps, on account of the fossils contained in the so-called Intertrappean beds, as early tertiary. Hislop and Hunter compared the flora, of which a large collection of fruits, seeds, etc., was then available, with the Eocene flora of the London Clay, which Bowerbank[4] had described only a few years previously. Owing to certain unfortunate circumstances, which I hope to relate elsewhere, this important direct evidence of a tertiary age was allowed to recede into obscurity and oblivion; while indirect evidence, regarded as indicative of a cretaceous age and culled from distant areas like Sind and Baluchistan[5] or from the underlying Lameta series,[6] of which the exact relations with the traps are still an open question, has in recent years held almost undisputed field. In 1893, when the second edition of the Indian Geological Survey's official manual[7] was published, the whole question was discussed in detail on the evidence then available; but the conclusion there expressed was distinctly cautious and non-committal. To-day, the official view of the Survey[8] although admittedly based solely upon indirect evidence, regards the Deccan beds, almost without question, as belonging to the close of the mesozoic and not to the opening of the tertiary era. Until quite

[1] Malcolmson. *Trans. Geol. Soc., London*, 1837, **5**, 537; reprinted in Carter, *Geol. Papers on Western India*, 1857, 1-47.

[2] Hislop and Hunter, *Quart. Journ. Geol. Soc.*, 1855, **11**, 345; reprinted in Carter, *loc. cit.*, 247, *q.v.*: see also Hislop, *Journ. Bombay Asiat. Soc.*, 1853, **5**, 58-76; *Proc. Bombay Asiat. Soc.*, 1853, **5**, 148-150.

[3] Oldham, T., *Rec. Geol. Surv. Ind.*, 1871, **4**, 77.

[4] Bowerbank, *History of the Fossil Fruits and Seeds of the London Clay, London*, 1840.

[5] D'Archiac and Haime, *Descr. d. animaux foss. du groupe Nummulitique de l'Inde, Paris*, 1853; Duncan and Sladen, *Palæont. Indica*, 1871-1885, Ser. XIV, **1**, (iii, 1); Douvillé etc., *Palæont. Indica, N.S.*, 1927-1929, **10**, mem. 2, 3; but see also Holland, *Ind. Geol. Terminol., Mem. Geol. Surv. Ind.*, 1926, **51**, 51.

[6] Matley, *Rec. Geol. Surv. Ind.*, 1921, **53**, 142-164; see also Medlicott, H. B., *Rec. Geol. Surv. Ind.*, 1872, **5**, 115-120; Oldham, T., *loc. cit., supra*, 1871; Wadia, *Geol. of India*, 1926, pp. 190-191; Holland, *loc. cit.*, 1926.

[7] Oldham, R. D., *Manual of the Geology of India* (G.S.I. publication), 1893.

[8] Holland, "Indian Geological Terminology", *Mem. Geol. Surv. Ind.*, 1926, **51**, 64, 88; see also Wadia, *Geol. of India*, 1926, 200.

recently I was one of those who freely accepted this view. But a comprehensive review of the evidence, including some recent discoveries, has led me to abandon this opinion in favour of the conclusions reached by the pioneer workers.

I am deeply indebted to various officers of the Geological Survey and particularly to the distinguished head of that Department, Dr. L. L. Fermor, F.R.S., for their great courtesy in acquainting me with the geological literature in support of the official view and in replying to several other enquiries. I have no intention here, nor am I competent, to discuss this literature which must be familiar to all Indian geologists. My main purpose is to draw attention to the fact that *there is a considerable body of direct palæobotanical evidence, and that this evidence, as I stated in a recent note*[9], *points distinctly in favour of a tertiary age for the Intertrappean series.* I may say in passing, however, that while the fauna has been pronounced to be indecisive from the stratigraphical point of view[10] (most of the genera having long ranges in time), if the crustacean remains which Malcolmson[11] recorded from the Deccan beds nearly a century ago were correctly assigned to *Cypris*, we have some little evidence pointing in the same direction, even from the animal side because this genus is unknown in rocks older than the tertiary. But of course, until the reference to *Cypris* has been confirmed the evidence of the fauna must be regarded as neutral.

As for the plant remains, a provisional list with references to earlier papers was given in the preliminary paper already cited.[12] Since then, under very unusual circumstances, I have unearthed from the vaults of a Bombay museum an important old collection of silicified palms and dicotyledons, some of which were no doubt collected over a hundred years ago. This newly discovered, or rather re-discovered, material lends further support to the view I had already expressed. The whole of the Intertrappean material in hand is now being described in detail in collaboration with my research students Messrs. B. P. Srivastava, H. S. Rao and K. M. Gupta. Till this has been done, detailed comparisons cannot be made, but enough work has been accomplished to show that the assemblage as a whole cannot be compared with any known cretaceous flora: it is distinctly a tertiary assemblage, and probably a lower tertiary one. I may also add that the whole of this material comes from the lower part of the Intertrappean series and not from the regions to the south and west, where the rocks are even younger, those at Bombay, representing the top of the series, being several thousand feet higher.

The main arguments for a tertiary age are the following :—

(*a*) *The very large proportion of palms among the angiosperms in the Intertrappean flora.*—This proportion is even larger than would appear from the preliminary note cited above. Without committing myself to exact figures I may say that at the present moment, out of a total number of not more than 42 angiosperm species which have come to my notice, there are no fewer than 23 species of palms (18 of *Palmoxylon*, and at least 5 of fruits, besides one or two of leaves). Even allowing that all the fruits and leaves belonged to some of these 18 *Palmoxyla*, and making no such allowance in the case of the dicotyledonous fruits and leaves, the proportion of palms among the angiosperms remains strikingly high. It is generally agreed that the palms first arose in the cretaceous and rapidly increased and spread during the tertiary, when the family attained the zenith of its development. In no known cretaceous flora do the palms figure at all so prominently as they do in the Intertrappean flora.

(*b*) *The genus Azolla*, indeed the family Hydropterideæ as a whole, has never been recorded from rocks older than the tertiary. Both the previously described species, *A. prisca* Reid and Chandler[13] and *A. tertiaria* Berry,[14] come from tertiary strata.

(*c*) *The occurrence of Nipadites, a typically eocene genus.*—In the winter of 1930 the enthusiastic Benares geologist K. P. Rode

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[9] Sahni, Srivastava and Rao, "The silicified flora of the Deccan Intertrappean series," 1934, Parts I-IV, *Proc. Ind. Sci. Congress*, Botany Section, Bombay meeting, read January 1934, published March 1934.

[10] Wadia, *Geology of India*, 1926; R. D. Oldham, *loc. cit., supra*, 1893.

[11] Malcolmson, *loc. cit., supra*, 1837.

[12] Sahni, Srivastava and Rao, *loc. cit., supra*, 1934.

[13] Reid and Chandler, "The Bembridge Flora," *Brit. Mus. Catalogue*, 1926.

[14] Berry, *Proc. U. S. Nat. Mus.*, 1927, **72**, p. 4, pl. 1, figs. 9-10. Sporocarps were not observed, hence final proof of *Azolla* is lacking in this species.

brought to me at Lucknow a small but interesting collection of fossil plants collected by him near his own village Mohgaon Kalan, east of Chhindwara, in one of the basal members of the Intertrappean series. Among these I at once recognised an undoubted species of *Nipadites*, which thus confirmed Hislop's record of this genus, now eighty years old.[15] There were also some trilocular fruits specifically identical with specimens already lent me by the British Museum, as well as one or two new forms, and several species of *Palmoxylon*, three of which he described at my suggestion.[16] I had also suggested that he should describe the fruits, but unfortunately his paper on these,[17] unlike those on the *Palmoxyla*, was sent to press without my knowledge, and it contains a number of blunders. Nevertheless the importance of the discovery of an undoubted *Nipadites* (*N. hindi* Rode) in the Intertrappean beds must be fully recognised, although Rode himself did not see it. While it may be a matter of opinion whether this fossil should be placed in the genus *Nipadites* or referred to the modern genus *Nipa*, both the form and the structure which (with Mr. Rode's kind permission) I have described and figured in another paper, to be published shortly, leaves no doubt as to the affinity. There is no room for a spongy cavity above the seed, as there is in *Pandanus*[18]; there is a large basal aperture for the embryo to escape (not a "stalk-cavity" as described by Rode) and, lastly, the seed is very definitely grooved on one side as in the modern *Nipa* (not smooth as described by Rode). The angular form of the fruit, as well as the fibrous mesocarp (locally exposed by the abrasion of the thin epicarp) lends support to the affinity with *Nipa*. This discovery thus fully confirms the presence of *Nipadites* in the Intertrappean flora, first recorded by Hislop in 1853. The other species, named *N. compressus* by Rode, may or may not be a *Nipadites*. Nevertheless one of the most important points of resemblance with the London Clay flora has been fully established, and it gives the strongest support to an eocene age for the Deccan beds.

One more point seems important although Rode himself does not refer to it. *Nipadites* is not only a genus very characteristic of the eocene period but, unless these palms have changed their mode of life since then, its occurrence in the northern part of the Deccan indicates the existence of an *estuary*, during the early part of the Intertrappean period in the proximity of Chhindwara. In their valuable memoir on the London Clay flora recently published Reid and Chandler[19] have shown that nearly all the fossil records of *Nipa*-like palms "lie approximately along the margins of the ancient Nummulitic, or Tethys, sea and its extensions". So, most probably a north-flowing river debouched into the great Tethys sea or into an arm of that sea, not far to the north of Mr. Rode's home! We may now confidently look forward to the discovery of further evidence of an estuarine flora along the northern and eastern borders of the Deccan Trap area, perhaps particularly in the region of Rajahmundry, from where a brackish water fauna is already known.

The above, briefly, are the main considerations which taken together have led me, in spite of the official view of the Indian Geological Survey, to assign an eocene age to the Deccan Traps. This view not only vindicates the opinion expressed by the pioneer workers, but is also in consonance with the conclusion recently arrived at by Sir Arthur Smith Woodward, F.R.S.[20] from the indirect testimony of some fish remains from beds believed to belong to the Lameta series.

I cannot conclude this note without an expression of sincere thanks to Mr. Rode and also to Dr. Fermor and his colleagues, to whom I owe much of the information and material which I have here used, perhaps somewhat ungratefully, in support of opinions opposed to theirs.

[15] Hislop, *Journ. Bombay Asiat. Soc.*, 1853, **5**, 68; Carter, *loc. cit.*, 1857, 718; see also Hislop and Hunter, 1855, in Carter, p. 264.

[16] Rode, *Quart. Journ. Geol. Min. and Met. Soc. of India*, 1933, **5**, (ii, iii), *Calcutta*.

[17] Rode, *Curr. Sci.*, 1933, **2** (v), 171-172, *Bangalore*.

[18] Rode's fig. 2 on p. 172 is, however, hypothetical, as the distal half of the fossil has not been cut longitudinally.

[19] Reid and Chandler, "The London Clay Flora", *Brit. Mus. Nat. History, London*, 1933.

[20] Smith-Woodward, A., *Palæont. Indica, N. S.*, 1908, **3** (iii), 1-6; a view recently confirmed by him in a letter to me, dated 1934.

# Some Recent Advances in Indian Geology.*

By W. D. West,
*Geological Survey of India.*

## INTRODUCTION.

THE Editor of *Current Science* has asked me to contribute an article on recent advances in Indian geology. The following notes, dealing with certain aspects of the subject with which I am more familiar, have been put together in the hope that they may prove to be of interest not only to students of geology in India, but also to geologists outside India who have not the time to keep in touch with developments in this country.

Perhaps the most disturbing feature of modern scientific work is the immense output of literature which is continually appearing in every branch of science. So great is this becoming that it is a matter of difficulty for any worker to keep in touch with the progress that is being made, even in his own subject. This difficulty applies with particular force to geology. Modern geology has become so comprehensive, and its various aspects have become so specialised, that it has been said that there are no longer any geologists but only specialists in various branches; while specialists have been defined as those who know more and more about less and less. India is a large place, with a very varied geology and the considerable number of papers on Indian geology that are continually appearing, overburdened as they often are with the details of their subject, make it difficult for anyone not directly interested in them to appreciate fully the progress that is being made. In writing these notes, therefore, I have tried as far as possible to draw attention to the main lines along which our understanding of the geology of India is developing, rather than to summarise every paper that has recently appeared, which would in any case be impossible within the limits of a series of short articles.

I have divided this account into five sections: (1) The Archæan Rocks of Peninsular India, (2) Deccan Trap volcanic activity, (3) The geology of the Himalaya, (4) The geology of Burma, (5) The geology of the Salt Range. A section dealing with recent advances in palæontology by Mr. D. N. Wadia has already appeared in *Current Science* (December, 1933). The section on the geology of Burma is being contributed by my colleague Mr. V. P. Sondhi, to whom I am much indebted.

## THE ARCHÆAN ROCKS OF PENINSULAR INDIA.

The Archæan rocks of India occupy a greater area than any other formation. They are important economically in containing rich deposits of gold, iron, manganese and mica. It is unnecessary to stress the importance of pure scientific research in the bearings which it may have on economic development; and a detailed study of the Archæan rocks in India, such as is being carried on in certain areas, needs no further justification. The problems associated with Indian Archæan geology are so many, and their proper discussion would be so laborious, that in the following notes only a very general account can be given of the main trend of recent work. It is unfortunate that most of this work is yet unpublished, and some indication of the lines along which it is developing may therefore prove to be of value.

The peculiar difficulties that beset the geologist who is endeavouring to interpret the geological history of Archæan times are well known. The metamorphism which these rocks have undergone has in some cases made originally dissimilar rocks appear similar, while in other cases the same rocks have been made to appear profoundly different in different places where they have suffered varying degrees of metamorphism. A further difficulty in the way of correlating these very old rocks is that many of their outcrops have become isolated from one another, either by the denudation of intervening tracts or by the superposition of later rocks; and it is difficult sometimes to be certain whether a difference observed in the rocks of two neighbouring but separated tracts is due to actual difference in the age of the rocks, or to lithological variation, or to the effects of varying metamorphism.

Before referring to the recent advances made in this branch of Indian geology a word may be given about the classification

* Published with the permission of the Director, Geological Survey of India.

brought to me at Lucknow a small but interesting collection of fossil plants collected by him near his own village Mohgaon Kalan, east of Chhindwara, in one of the basal members of the Intertrappean series. Among these I at once recognised an undoubted species of *Nipadites*, which thus confirmed Hislop's record of this genus, now eighty years old.[15] There were also some trilocular fruits specifically identical with specimens already lent me by the British Museum, as well as one or two new forms, and several species of *Palmoxylon*, three of which he described at my suggestion.[16] I had also suggested that he should describe the fruits, but unfortunately his paper on these,[17] unlike those on the *Palmoxyla*, was sent to press without my knowledge, and it contains a number of blunders. Nevertheless the importance of the discovery of an undoubted *Nipadites* (*N. hindi* Rode) in the Intertrappean beds must be fully recognised, although Rode himself did not see it. While it may be a matter of opinion whether this fossil should be placed in the genus *Nipadites* or referred to the modern genus *Nipa*, both the form and the structure which (with Mr. Rode's kind permission) I have described and figured in another paper, to be published shortly, leaves no doubt as to the affinity. There is no room for a spongy cavity above the seed, as there is in *Pandanus*[18]; there is a large basal aperture for the embryo to escape (not a "stalk-cavity" as described by Rode) and, lastly, the seed is very definitely grooved on one side as in the modern *Nipa* (not smooth as described by Rode). The angular form of the fruit, as well as the fibrous mesocarp (locally exposed by the abrasion of the thin epicarp) lends support to the affinity with *Nipa*. This discovery thus fully confirms the presence of *Nipadites* in the Intertrappean flora, first recorded by Hislop in 1853. The other species, named *N. compressus* by Rode, may or may not be a *Nipadites*. Nevertheless one of the most important points of resemblance with the London Clay flora has been fully established, and it gives the strongest support to an eocene age for the Deccan beds.

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I cannot conclude this note without an expression of sincere thanks to Mr. Rode and also to Dr. Fermor and his colleagues, to whom I owe much of the information and material which I have here used, perhaps somewhat ungratefully, in support of opinions opposed to theirs.

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[15] Hislop, *Journ. Bombay Asiat. Soc.*, 1853, **5**, 68; Carter, *loc. cit.*, 1857, 718; see also Hislop and Hunter, 1855, in Carter, p. 264.

[16] Rode, *Quart. Journ. Geol. Min. and Met. Soc. of India*, 1933, **5**, (ii, iii), *Calcutta*.

[17] Rode, *Curr. Sci.*, 1933, **2** (v), 171-172, *Bangalore*.

[18] Rode's fig. 2 on p. 172 is, however, hypothetical, as the distal half of the fossil has not been cut longitudinally.

[19] Reid and Chandler, "The London Clay Flora", *Brit. Mus. Nat. History, London*, 1933.

[20] Smith-Woodward, A., *Palæont. Indica, N. S.*, 1908, **3** (iii), 1-6; a view recently confirmed by him in a letter to me, dated 1934.

# Some Recent Advances in Indian Geology.*

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## INTRODUCTION.

THE Editor of *Current Science* has asked me to contribute an article on recent advances in Indian geology. The following notes, dealing with certain aspects of the subject with which I am more familiar, have been put together in the hope that they may prove to be of interest not only to students of geology in India, but also to geologists outside India who have not the time to keep in touch with developments in this country.

Perhaps the most disturbing feature of modern scientific work is the immense output of literature which is continually appearing in every branch of science. So great is this becoming that it is a matter of difficulty for any worker to keep in touch with the progress that is being made, even in his own subject. This difficulty applies with particular force to geology. Modern geology has become so comprehensive, and its various aspects have become so specialised, that it has been said that there are no longer any geologists but only specialists in various branches; while specialists have been defined as those who know more and more about less and less. India is a large place, with a very varied geology and the considerable number of papers on Indian geology that are continually appearing, overburdened as they often are with the details of their subject, make it difficult for anyone not directly interested in them to appreciate fully the progress that is being made. In writing these notes, therefore, I have tried as far as possible to draw attention to the main lines along which our understanding of the geology of India is developing, rather than to summarise every paper that has recently appeared, which would in any case be impossible within the limits of a series of short articles.

I have divided this account into five sections: (1) The Archæan Rocks of Peninsular India, (2) Deccan Trap volcanic activity, (3) The geology of the Himalaya, (4) The geology of Burma, (5) The geology of the Salt Range. A section dealing with recent advances in palæontology by Mr. D. N. Wadia has already appeared in *Current Science* (December, 1933). The section on the geology of Burma is being contributed by my colleague Mr. V. P. Sondhi, to whom I am much indebted.

## THE ARCHÆAN ROCKS OF PENINSULAR INDIA.

The Archæan rocks of India occupy a greater area than any other formation. They are important economically in containing rich deposits of gold, iron, manganese and mica. It is unnecessary to stress the importance of pure scientific research in the bearings which it may have on economic development; and a detailed study of the Archæan rocks in India, such as is being carried on in certain areas, needs no further justification. The problems associated with Indian Archæan geology are so many, and their proper discussion would be so laborious, that in the following notes only a very general account can be given of the main trend of recent work. It is unfortunate that most of this work is yet unpublished, and some indication of the lines along which it is developing may therefore prove to be of value.

The peculiar difficulties that beset the geologist who is endeavouring to interpret the geological history of Archæan times are well known. The metamorphism which these rocks have undergone has in some cases made originally dissimilar rocks appear similar, while in other cases the same rocks have been made to appear profoundly different in different places where they have suffered varying degrees of metamorphism. A further difficulty in the way of correlating these very old rocks is that many of their outcrops have become isolated from one another, either by the denudation of intervening tracts or by the superposition of later rocks; and it is difficult sometimes to be certain whether a difference observed in the rocks of two neighbouring but separated tracts is due to actual difference in the age of the rocks, or to lithological variation, or to the effects of varying metamorphism.

Before referring to the recent advances made in this branch of Indian geology a word may be given about the classification

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of these old rocks. This question of nomenclature is a thorny one, and perhaps the less said the better. But two points call for comment. It is becoming increasingly clear, more especially as the result of Dr. A. M. Heron's researches in Rajputana, that the old metamorphosed rocks of India of undoubted sedimentary origin have to be subdivided into two or three systems, separated from each other by big unconformities. The term Archæan was first introduced by Dana in 1872 to include all rocks older than the Cambrian.[1] But it is the custom in many countries to restrict its use to the more highly metamorphosed rocks older than the Cambrian, and to designate the less metamorphosed rocks as Pre-Cambrian or some such term. As regards India, in 1906 Sir Thomas Holland divided all rocks older than the Cambrian as follows:[2]

| | | |
|---|---|---|
| Purana | .. | Cuddapah to Vindhyan. |
| Archæan | .. | Dharwarian<br>Eruptive gneisses and granites<br>Schistose gneisses<br>Oldest gneisses. |

Such a classification, while it may have served a useful purpose nearly 30 years ago, is clearly inadequate at the present day. It is not proposed here to suggest any alternative. But the work that is gradually being completed in the several Archæan tracts in India, which is referred to in the following notes, should, after the effects of varying metamorphism and of changing lithology have been disentangled, lead in the end to a natural classification based on fuller data than are at present available.

The other point which must be referred to here concerns the use of the word 'Dharwar'. Until quite recently this name has been used to embrace all the bedded schists of Archæan age, including both metamorphosed sediments and contemporaneous lava flows.[3] But the recent work[4] in Rajputana and Bihar and Orissa has indicated the presence of two or more series within the Archæan, separated from one another by unconformities. The use of the term Dharwar in its original comprehensive sense can thus no longer be maintained. To avoid misunderstanding it will therefore be better in future to refer to the Archæan rocks of each tract by their local names, the term Dharwar being restricted to the rocks of the Dharwar district and adjacent tracts in Mysore. In this way no implication of correlation will be introduced into the nomenclature which is not justified by the known facts.

In the following account attention will be confined to the four tracts in which detailed work has recently been done.

### RAJPUTANA.

In Rajputana Dr. A. M. Heron, who commenced work there in 1908, has now completed the mapping of the crystalline rocks, and the publication of the details of his work is being eagerly awaited. As a result of this work two points are clearly brought out which are of particular interest. First, the necessity of dividing the crystalline rocks of this area into four distinct groups or systems, separated from each other by marked unconformities frequently accompanied by conglomerates. Second, the remarkable way in which some of the oldest rocks in India are in certain places still in the condition of almost unaltered shales and slates.

As regards the former point, the crystalline rocks of Rajputana have to be divided into the following groups, given in order:

Delhi system
— — — — unconformity with conglomerate
Raialo series
— — — — unconformity with conglomerate
Aravalli system
— — — — — unconformity with conglomerate
Banded Gneissic Complex

Of these the Raialo series, which includes the well-known Makrana marble, is the smallest and least important, and is often missing.[5] The Banded Gneissic Complex, to be distinguished from the injection gneisses formed by the intrusion of acid magma into the Aravallis and Delhis at a much later date, is thought to be the equivalent of the Bundelkhand gneiss of Eastern Rajputana, though the two are never seen in actual contact. They are mainly of igneous origin, but there do occur amongst them biotite- and chlorite-schists and granulites which may represent metamorphosed sediments greatly injected by both basic and acid rocks.[6] They are the oldest rocks in Rajputana.

Perhaps the feature of greatest interest which has been brought to light by Heron's

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[1] *Amer. Jour. Sci.*, 3rd series, 1872, **3**, 253.
[2] *Trans. Min. Geol. Inst. Ind.*, 1906, **1**, 47.
[3] *E.g.*, L. L. Fermor, *Mem. Geol. Surv. Ind.*, 1909, **37**, 1120; and J. A. Dunn, *op. cit.*, 1929, **54**, 151.
[4] *Rec. Geol. Surv. Ind.*, 1886, **19**, 98.
[5] *Op. cit.*, 1929, **62**, 172.
[6] *Op. cit.*, 1930, **63**, 143.

work is the way in which the Aravallis are in places still in the condition of practically unaltered shales and slates. We have, in fact, in Rajputana one of the largest areas in the world of Archæan rocks which have suffered little or no metamorphism, perhaps only to be parallelled by the little altered Archæan rocks of Finland. The way in which such rocks have escaped metamorphism during Archæan and later times is one of the most interesting problems of Indian Archæan geology. When traced along the strike to the south these Aravalli rocks become injected with acid magma on an immense scale, and the rock becomes a banded gneiss.[7] Further south still the injection dies out, and slates are found once more. These composite gneisses are described by Heron as being exactly similar to the injection gneisses in Sutherlandshire, Scotland, recently described by H. H. Read. In Eastern Rajputana the Aravalli rocks rest unconformably on the eroded surface of the Bundelkhand gneissose granite, and there seems to be no doubt now as to the relative ages of these rocks.

The Delhi system provides a problem of correlation which makes the geology of Rajputana of such intriguing interest. For the rocks of this system, although belonging to a late period of Archæan geology, are considerably folded and highly metamorphosed. They are in fact in many parts of Rajputana more highly metamorphosed than the older Aravalli rocks. To understand how this has come about it is necessary to state that structurally Rajputana is dominated by the great Delhi synclinorium, which runs in a N.E.–S.W. direction in north-east Rajputana, swinging round to a N.–S. direction in southern Rajputana and Bombay. Heron describes it as having roughly the shape of an hour glass, being narrowest in the centre and splaying out in the north-east and in the south. This is due to the fact that in the centre the syncline is a simple fold, but to the north-east and to the south it becomes complicated by the appearance of many secondary folds, and the outcrop becomes much wider. The fact that the Delhi rocks in the centre of the synclinorium are more highly metamorphosed than the older Aravalli rocks, is thought by Heron to be due to the fact that they were more deeply buried and more greatly intruded by igneous rocks than the underlying Aravalli rocks which are only seen in the outer parts of the synclinorium.[8] This anomaly of metamorphic grade leads C. S. Middlemiss to adopt a reversed order of superposition for the Aravallis and Delhis in Idar State, at the south-west end of the synclinorium.[9] But Middlemiss, in investigating only a small area, was handicapped in being confined in his work to a comparatively short distance along the strike; and moreover the Delhi-Aravalli unconformity is not recognisable as such within Idar, while inversion and overfolding are general. The later work of Heron, carried on over a greater area, and including the tracing of the Delhi-Aravalli unconformity for something like 500 miles, and the mapping of the lower unconformity of the Aravallis upon the Bundelkhand gneiss and the banded gneisses, has settled definitely the age relations between the major rock groups of Rajputana.

In post-Delhi times the south-western side of the synclinorium was swamped with great intrusions of granite at two different periods. These igneous rocks, together with four different sets of basic intrusions and extrusions, have been described in detail by A. L. Coulson in his account of the geology of Sirohi State.[10] The first acid phase includes the Erinpura granite and its associated aplites and pegmatites, intrusive into both Aravalli and Delhi rocks. No volcanic rocks are found associated with this phase. The second phase of acid intrusion is known as the Malani system. It includes the Idar granite as the plutonic phase, a variety of quartz-porphyries, felspar-porphyries, granophyres and similar rocks as the hypabyssal phase, and rhyolites and dellenites as the volcanic phase, including the well-known Malani rhyolites. Of considerable petrographical interest is the suite of igneous rocks intruded into the Erinpura granite near the village of Mundwara, on the western border of the State. These include picrites, gabbros and dolerites, basalts and pyroxenites, sodalite-syenites, and agglomerates. The memoir is accompanied by a large number of chemical analyses, which add to the interest of the petrographical descriptions.

On the eastern side of the Delhi synclinorium, B. C. Gupta has described the geology

[7] *Op. cit.*, 1929, **62**, 171-172.

[8] *Op. cit.*, 1931, **65**, 143-144.

[9] *Mem. Geol. Surv. Ind.*, 1921, **44**, pt. 1.

[10] *Op. cit.*, 1933, **63**, pt. 1.

of Central Mewar in a memoir which is now in the press.[11] The paper is of value in giving a detailed description of the Banded Gneissic Complex and of the Bundelkhand gneiss. Although the two are everywhere separated by a belt of Aravalli rocks, and although where seen on either side of the belt they are markedly different, Gupta agrees with Heron in regarding them as roughly the same. He looks upon the Bundelkhand gneiss as having crystallised under very deep-seated conditions, while the gneissic complex with its heterogeneous structure is thought to have been formed in a higher zone of the earth's crust, where there was more opportunity for the incidence of directed pressure, as well as a fairly high temperature. The Aravallis rest on both with an erosion unconformity, sometimes accompanied by conglomerates.

### Central Provinces.

In the Central Provinces, what is undoubtedly the most detailed mapping that has so far been attempted in Indian Archæan geology has been carried out by Dr. L. L. Fermor and his co-workers in the Nagpur, Chhindwara and Bhandara districts. It is a matter for regret that the full details of this work are unlikely to be published for some time to come, though summaries are to be found in the Director's annual reports.[12]

This series of Archæan rocks, named the Sausar series, are economically important for the rich deposits of manganese ore that they contain. They have been divided up into a number of stages which have a remarkable constancy over the area in which they have so far been mapped. These stages are so distinct, and their order now so well established, that it is worth while giving them in detail here, for comparison with other areas.

| | |
|---|---|
| Sitapar stage .. | Hornblende-schists. |
| Bichua stage .. | *Pure facies:* white dolomitic marbles, with serpentine, tremolite, and diopside. *Impure facies:* diopsidites, actinolite schists, and schists with wollastonite, grossularite, tremolite, and anthophyllite. |
| Junewani stage .. | Muscovite-biotite-schists with autoclastic conglomerates. |
| Chorbaoli stage (= Ramtek stage) | Quartzites and muscovite-quartz-schists. |
| Mansar stage .. | Muscovite-biotite-sillimanite-schists, with lenticular beds of manganese ore. |
| Lohangi stage .. | Pink calcitic marble and calciphyres. |
| Utekata stage .. | Banded calc granulites. |
| Kadbikhera stage | Megnetite-biotite granulites. |

The Ramtek stage was originally given a separate position, but it is probably identical with the Chorbaoli stage. All these stages with the exception of the Sitapar stage, the hornblende-schists of which probably represent metamorphosed lava flows, are now regarded as of sedimentary origin.

In the Sausar tahsil and in the northern part of the Ramtek tahsil these rocks display a very high grade of metamorphism, the characteristic pelitic rock being a garnet sillimanite-biotite-schist, while in the dolomitic rocks the mineral wollastonite occurs. But traced to the south and to the east the grade of metamorphism decreases, so that while in the northern and western parts of the area the manganese ore occurs in a muscovite-biotite-sillimanite-schist, with or without garnet, in the southern part of the area, around the manganese mines of Kandri and Mansar, the country rock is a muscovite-phyllite or schist, in which biotite is very subordinate. In both cases the stage is the same, being overlain and underlain by the same rocks in both areas. Accompanying the increasing metamorphism in the north there is a great abundance of pegmatite intrusions.

The complexity of the folding in these rocks is very great, and W. D. West has brought forward evidence for the existence of a 'nappe' in the vicinity of Deolapar, in the Ramtek tahsil, whereby slightly different lithological facies of the Sausar series, originally deposited far apart, have been brought into juxtaposition with one another.[13]

In addition to these metamorphosed sedimentary rocks, there are a variety of porphyritic and fine grained granites, pegmatites and ortho-gneisses which are younger than the Sausar series. There is also a gneiss which has gone by the general name of 'streaky gneiss'. In places this occupies as great an area as the Sausar series. It has been shown by West that much of this rock is really a composite or injection gneiss, formed by the intimate penetration of an igneous granulite of granodioritic

11 *Op. cit.*, 1934, **65**, pt. 2.

12 See especially, *Rec. Geol. Surv. Ind.*, 1931, **59**, 143-44 and *op. cit.*, 1931, **65**, 100-101.

13 *Rec. Geol. Surv. Ind.*, 1931, **65**, 102-104.

composition by abundant veins of aplite.[14] Similar injection has affected the more schistose members of the Sausar series, especially the Mansar stage. All these gneisses are definitely younger than the Sausar series, and there seems to be nothing in this area comparable to the banded gneissic complex of Rajputana, upon which the Sausar series might have been laid down.

To the south and south-east of this tract of the Sausar series there occurs an area of very much less metamorphosed rocks, known as the Sakoli series. These have been studied by D. S. Bhattacharji and S. K. Chatterjee, who have shown them to consist of phyllites and slates, hæmatite-sericite-quartzites, chlorite-schists and jaspilites.[15] They are mostly separated from the Sausar series by alluvium; but where the two series are seen adjacent to one another the evidence suggests that the Sakoli series are but the upward continuation of the Sausar series. The much lower grade of metamorphism is due, according to Chatterjee, to their having suffered retrograde metamorphism. They will be referred to again below.

### BIHAR AND ORISSA.

Turning now to the third area in northern India where detailed work has been done, Bihar and Orissa, we find that, excluding younger pre-Cambrian rocks which are perhaps of Cuddapah age, there are three distinct lithological series of Archæan age, as follows:

Iron-ore series, with Dalma volcanic flows and tuffs at the top.

— — — — — — — — — — — — —

Gangpur series, limestones and schists with manganese ore.

— — — — — — — — — — — — —

Older Metamorphic series.

The oldest, composed mainly of hornblende-schists and quartzites, resemble lithologically the Dharwars of South India. The Gangpur series, recently mapped by M. S. Krishnan, show a considerable resemblance to the Sausar series.[16] Dr. Fermor has always maintained that the manganese ores of India very probably occupy a single horizon within the Archæan, and in Gangpur State the presence of manganese ore and of both calcitic and dolomitic limestones suggests a correlation with the Sausar series. These rocks are separated from the Iron-ore series by a belt of crushing, so that the relation between the two is obscure. They bear, however, no lithological resemblance to one another, although found in adjacent tracts. The Iron-ore series are found resting with a strong unconformity upon the Older Metamorphic rocks, as first shown by H. C. Jones.[17] They are too well known to need description, but J. A. Dunn's recent memoir brings out well the way in which a single series of rocks may show very different grades of metamorphism in different places.[18] In South Singhbhum the Iron-ore series is little metamorphosed or disturbed; but northwards both the metamorphism and the folding increase, until in North Singhbhum the rocks are highly metamorphosed and severely folded. Previously the Iron-ore series, partly on account of its little metamorphism in South Singhbhum and partly on account of the fact that it rests unconformably on older metamorphic rocks, had been regarded by Jones as likely to be of Cuddapah age, the underlying metamorphic rocks being referred to as Dharwar. Both these series are now included by Dunn within the Dharwar system, using the term Dharwar as synonymous with metamorphosed Archæan sediments and including all the schists below the Eparchæan unconformity. The chief reason he puts forward for supposing them to be older than Cuddapah age is that they are intruded by gneissic granites which are themselves intruded by dolerites (in places metamorphosed to epidiorites). And since no intrusions of dolerites have been known in Peninsular India between Cuddapah and Rajmahal (Jurassic) times, it is deduced that the Iron-ore series, the granites, the dolerites, and the folding and metamorphism are all older than Cuddapah, and therefore Archæan in age.

The Chota Nagpur granite-gneiss, and the Singhbhum and other granites, have been studied in detail by Dunn and by L. A. N. Iyer.[19] They are intruded into the Iron-ore series, but are all regarded as Archæan in age. The reaction between these granites and the country rocks, which has given rise to hybrid rocks and synantetic minerals, is discussed by Iyer, who has also

[14] *Op. cit.*, 1933, **67**, 304.
[15] *Op. cit.*, 1929, **62**, 132-133 and *op. cit.*, **65**.
[16] *Op. cit.*, 1933, **67**, 63-65.
[17] *Op. cit.*, 1922, **54**, 41.
[18] *Mem. Geol. Surv. Ind.*, 1929, **54**.
[19] *Ibid.*, chaps. X and XI; and *Rec. Geol. Surv. Ind.*, 1932, **65**, 490.

furnished a number of chemical analyses of the various granites.

SOUTH INDIA.

In 1886 R. Bruce Foote mapped the rocks around Bellary and Dharwar, south of the great Deccan Trap outcrop.[20] The belts of schistose rocks which overlie the main gneissic foundation, consisting of hornblende schists, chlorite-schists, quartzites, banded hæmatite-quartzites, limestones and conglomerates, were named by him the Dharwar system, and were thought to overlie the gneisses unconformably, which were therefore regarded as the older. Subsequent work, however, has shown that these gneisses frequently show intrusive relations towards the Dharwars, and they are now regarded as younger. As regards the nature of the Dharwars, it was formerly assumed that, apart from the hornblende schists and epidiorites, the majority were metamorphosed sediments. Of late, however, the Mysore Geological Department have concluded that nearly all the rocks of the Dharwar system are of igneous origin, while the conglomerates are regarded as autoclastic. This point of view is summarised by W. F. Smeeth in 'An Outline of the Geological History of Mysore', in Bulletin No. 6, Department of Mines and Geology, Mysore State. With reference to this change of view, C. S. Middlemiss in 1919 wrote as follows:[21]

> 'So far I think I am right in saying that no graphic representation of these extraordinary wholesale transformations of granites, quartz-porphyries and other igneous rock types, into schists, conglomerates, limestones and quartzites, has as yet appeared from the pencil of any of those responsible for the statements.'

So far as I am aware this detailed information is still not forthcoming, though it may probably safely be assumed that some at any rate of the rocks formerly regarded as sedimentary are of igneous origin, and that some of the conglomerates are autoclastic. It appears, however, that not all the geologists of the Mysore Geological Department are in agreement over the origin of these rocks, B. Rama Rao in particular suggesting that some of the crystalline schists may be metamorphosed sediments.[22]

In the above-mentioned paper Smeeth describes the Dharwars as being broadly divisible into an upper group consisting mainly of chlorite-schists, and a lower group consisting mainly of hornblende-schists. The granites and gneisses, now regarded as younger than the Dharwars, cover by far the greater part of the area. They include various types, of which the more important are the Champion gneiss, the peninsular gneiss, the Charnockite series, and the Closepet granite, in order of age. An account of these is given by Sampat Iyengar in his presidential address before the Indian Science Congress.[23]

Compared with the Archæan rocks of other parts of India, the true Dharwars of the Dharwar district are lithologically similar to the Champaner series in Bombay, which have now been shown by Heron to be identical with the Aravalli system of Rajputana.[24] It is possible that the Aravalli rocks are continued southwards beneath the Deccan Trap to emerge in Dharwar and Mysore as Dharwar rocks. Recently considerable attention has been paid to some manganiferous marbles, spessartite-rocks and tarurites (veined hornblende-schists with secondary pyroxene) which occur near a place called Sakarsanhalli, in the Kolar district of Mysore State. Dr. Fermor considered these rocks similar to the manganiferous rocks in the Sausar series.[25] They were thought by B. Jayaram of the Mysore Geological Department to belong to a low horizon in the Dharwars, or even to an older series.[26] Later they were examined and mapped by P. Sampat Iyengar, who concluded that these varied rocks are not metamorphosed sediments or in any way comparable to the gondite series of the Central Provinces, but are altered phases of the hornblendic rocks, the alterations being brought about by the contact metamorphism of acidic intrusions and subsequent metasomatic or meteoric changes.[27] As, however, he applied a similar origin to the calc-granulites of the Sausar series which he saw at Utekata, about the sedimentary origin of which there is now not the slightest doubt, his conclusions regarding the rocks at Sakarsanhalli may be questioned. However,

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20 *Rec. Geol. Surv. Ind.*, 1886, **19**, 98.

21 *Proc. As. Soc. Beng.*, 1917, **13**, cxcviii.

22 *Rec. Mysore Geol. Dep.*, 1922, **21**, 186; *op. cit.*, 1924, **23**, 128; and *op. cit.*, 1925, **24**, 144-147.

23 *Proc. Seventh Ind. Sci. Congr.*, 1921, cxv.

24 *Rec. Geol. Surv. Ind.*, 1934, **68**, pp. 24-25.

25 *Op. cit.*, 1926, **59**, 92.

26 *Rec. Mysore Geol. Dep.*, 1923, **22**, pt. 2, 35.

27 *Op. cit.*, 1931, **30**, 14-18.

in a very recent paper by M. B. Ramachandra Rao and K. Sripada Rao on the origin and correlation of these rocks, the same conclusion is reached that they are altered phases of the hornblende-schists of the lower division of the Dharwars and not metamorphosed sediments.[28] For the time being, then, the origin of these rocks must remain uncertain, though it is evident that they are very similar lithologically to parts of the Sausar series.

### CORRELATION.

A condensed statement of the Archæan rocks in different parts of India has been given by J. A. Dunn.[29] This is of value in drawing attention to the difficulties of the problem, but his final table of correlation probably requires modification. For reasons given at the beginning of this article, it is impossible at present to correlate the Archæan rocks of the various tracts in India. But certain lines along which this may ultimately be accomplished are becoming clearer, and may be referred to briefly here.

Dr. Fermor has advanced the view that the manganese ores in the Archæan rocks of India are likely to be all of one age, and he has accordingly suggested that all Archæan rocks which contain syngenetic manganese should be taken to be of the same age, especially if they are associated with crystalline marbles, as in the Central Provinces.[30] The correlation of the Sausar series in the Central Provinces with the Gangpur series in Bihar and Orissa is a natural consequence of this hypothesis. Further, he has suggested that the Iron-ore series of Bihar and Orissa may be the same as the Sakoli series in the Central Provinces, both containing hæmatite rocks, and both being devoid of marbles.[31] At any rate it seems safe to suggest that the Sausar series and Sakoli series are together equivalent to the Gangpur series and Iron-ore series.

As regards the other Archæan tracts in India, it has already been indicated that the Aravallis of Rajputana and the Champaners of Bombay are lithologically similar to the Dharwars of South India, and it is possible that the two are continuous beneath the Deccan Trap of the Bombay Presidency. Thus, viewed broadly, we seem to have two belts of Archæan sedimentary rocks in India, within each of which the rocks can be roughly correlated; the Aravalli-Champaner-Dharwar belt, with a meridional extension, and the Central Provinces-Bihar and Orissa belt, with an equatorial extension. The difficulty arises when we try to find some common factor between these two belts which may be of correlative value. If we try to correlate the Sausar series of the Central Provinces with one of the three metamorphosed sedimentary systems in Rajputana on lithological grounds, it seems clear that they bear most resemblance to the Delhi system, with its calc-gneisses, mica-schists and quartzites. But the fact that manganese occurs in the Champaner series, which is the same as the Aravalli system, suggests, as Dr. Fermor has pointed out, a correlation of the Sausar series with the Aravallis, though the two are not particularly alike lithologically.[32] This separation of the Archæan tracts into two belts on structural and lithological grounds should not be allowed to obscure the probability of the Aravalli strike in south-east Rajputana curving round so as to join up with the E.-W. strike of the Central Provinces. The completed mapping of the older rocks of Rajputana shows that in the south the strike splays out to the south and to south-east before it plunges beneath the later Deccan Trap, as a glance at the new geological map of India will show. And it is quite possible that the south-eastern wing continues on beneath the Deccan Trap towards the Archæan rocks of the Central Provinces. It is true that some of the manganese in the Champaners may not be of syngenetic origin; but the occurrence of manganese ore of true gonditic affinities in Aravalli phyllites in Jhabua State certainly suggests an affinity between the Sausar series and the Aravalli system. The only alternative is the possibility that there are two horizons of manganese in the Archæan rocks of India, which Dr. Fermor thinks unlikely. As a possible means of correlation between the Central Provinces and South India, the manganiferous rocks at Sakarsanhalli, in Mysore State, have already been referred to. But the present uncertainty as to their origin makes their value for purposes of correlation rather doubtful. The only other similarity that one can point to between the rocks of the two belts is the lithological resemblance between the Older

[28] *Bull. Mysore Geol. Dep.*, 1934, No. 14.

[29] *Aust. Assn. Adv. Sci.*, 1926, **18**, 291.

[30] *Rec. Geol. Surv. Ind.*, 1926, **59**, 80.

[31] *Op. cit.*, 1933, **67**, 65.

[32] *Op. cit.*, 1934, **68**, 26.

Metamorphic series of Bihar and Orissa and the Dharwars of South India. This correlation, however, introduces several difficulties.

Finally, considering broadly the ancient metamorphic rocks of Rajputana, it will be found that they differ from those in other parts of India in two main respects. (1) They include a basal gneissic complex, upon which the metamorphosed sedimentary rocks rest unconformably, in contrast to other Archæan tracts in India where the ortho-gneisses have in every case been proved to be younger than the sedimentary schists. (2) They include three or four distinct systems of rocks separated by marked unconformities. This fact has led Heron to believe that the Delhi system is a post-Archæan formation.[33] The high degree of metamorphism and folding to which the Delhi rocks have been subjected is regarded as a phenomenon which was peculiar to Rajputana at so late a stage in pre-Cambrian times. On this assumption there are two alternatives.

(1) That the Delhis were roughly contemporaneous with the Cuddapahs, and that, as Heron has put it:

> 'They owe their folding and the related intrusion of granite batholiths to a special local upheaval in Rajputana which did not affect the rest of India, or to local persistence of disturbance in Rajputana after it had almost died out elsewhere.'

(2) That the Delhis are older than the Cuddapahs, but have no equivalents in other parts of India.

This is probably about as far as one can safely go at present with regard to correlation. But the advances which have been made in our knowledge of the Archæan rocks of India during the past ten or twelve years have been so considerable, that one may be fairly hopeful as to the eventual solution of many of the problems which to-day seem so puzzling. Dr. Fermor is believed to be reviewing the Archæan rocks of India in a comprehensive manner. The publication of his conclusions, based as they are upon an exceptional experience of the Archæan rocks of most parts of India, will be looked forward to with great interest.

In the accompanying table, summarising the classification of the older rocks in the four chief tracts in India that have so far been studied in detail, no correlation is intended between one area and another.

| Rajputana | Central Provinces |
|---|---|
| Delhi system | Ortho-gneisses |
| Raialo series | Sakoli series |
| Aravalli system | Sausar series |
| Bundelkhand gneiss and Gneissic complex | |

| Bihar and Orissa | South India |
|---|---|
| Granitic rocks | Cuddapah system |
| Iron-ore series | Ortho-gneisses |
| Gangpur series | Dharwar system |
| Older metamorphics | |

[33] *Mem. Geol. Surv. Ind.*, 1917, **45**, pt. 1, pp. 110-116.

## Technological Researches at the University of the Punjab.

In recognition of the valuable researches of basic importance to the Petroleum Industry conducted by Dr. S. S. Bhatnagar, Director, Punjab University Chemical Laboratories, Messrs. Steel Brothers Company Ltd., Agents, Indo-Burma and the Attock Oil Company, Ltd., have placed at the disposal of Prof. Bhatnagar, a sum of $1\frac{1}{2}$ lakhs of rupees for research work on Petroleum and Allied subjects which will be paid in equal instalments over a period of five years. Messrs. Millar and Ward, Agents of Messrs. Steel Brothers, made a lumpsum grant to Prof. Bhatnagar as a personal gift, but the Professor offered to place the money at the disposal of the Punjab University, an offer which was thankfully accepted, with a view to inaugurating a department of Petroleum Research under his guidance.

One of the features of the scheme is that all results of a patentable nature will be exploited jointly by Messrs. Steel Brothers and Prof. Bhatnagar and/or his chemists and the profits will be shared equally between the Company and the parties concerned. Dr. Bhatnagar proposes to give the University a large share of his profits for the furtherance of scientific, industrial and medical research in the University.

# Intra-Molecular Rotation in Organic Compounds.

By M. A. Govinda Rau, M.A., Ph.D.
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AMONG the movements that the atoms can perform inside a molecule, that which is of special interest to the organic chemist is the so-called "inner rotation," *i.e.*, the rotation of molecular parts about each other. The degree of this internal freedom is also of great significance in the study of the physical properties of molecules, such as dipole moments and specific heats: thus in any quantitative calculation of the specific heat of a molecule from the data on the fundamental oscillation frequencies provided by Raman spectra, the degree of internal rotation must also be taken into consideration. It was one of the fundamental assumptions in organic chemistry that atomic groups bound by double or triple bonds could not rotate about each other, but when they were joined by only a single bond a free rotation should be expected. The limitations of this concept have been made evident from two typical investigations. L. Ebert[1] has shown that *cis* and *trans* ethylene isomers can change each into the other at temperatures not by any means high, and reach an equilibrium state. On the other hand, by the resolution of diphenyl derivatives containing two or more substituents in the 2 2′6 6′ positions, into optical antipodes by Mills, Adams and others,[2] it has been shown that the rotation about a single bond is not always free, but can be strongly restricted through the influence of substituents. The point is thus clear that rotation about any bond is a possibility and that rotation about each type of bond can be restricted to different extents according to the conditions prevailing inside the molecule. In recent years* the mathematics of quantum and wave mechanics have been applied to this problem by Mullikan,[3] Slater,[4] Pauling,[5] Hückel,[6] Dunkel,[7] Penney,[8] and Penney and Sutherland.[9] Summary reviews of this subject from special points of view have also been very recently published.[10]

The causes for restriction of rotation can be classified into (*a*) steric forces, (*b*) multiple bonds, and (*c*) energy troughs. In general the mechanism for the restriction of rotation is that the potential energy between the rotating parts of the molecule is not independent of the angle of rotation, but changes with it. Let us take a simple case where the potential energy-angle of rotation curve has the shape shown in Fig. 1

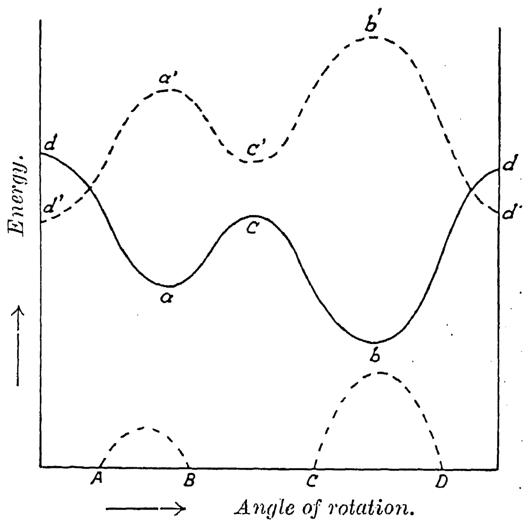


**Fig. 1.**

(*d a c b d*), with two energy minima *a* and *b*. At a particular high temperature, the kinetic energy of the rotating parts of the molecule can be represented by the dotted line *d′ a′ c′ b′ d′*. Such a line will have a maximum where the potential energy has a minimum, and represents a fully developed rotation. When the temperature is reduced the line of kinetic energy will sink,

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[1] L. Ebert and R. Bull, *Z. Physikal Ch.* (A), 1931, **152**, 451.

[2] R. Adams, *Chemical Rev.*, 1933, **12**, 261.

* One of the earliest attempts at a quantitative interpretation of intra-molecular rotation seems to be that of H. Sachse, *Z. Physikal Ch.*, 1893, **11**, 185.

[3] R. Mullikan, *Phys. Rev.*, 1933, **43**, 279.

[4] J. C. Slater, *Ibid.*, 1931, **37**, 481.

[5] L. Pauling, *J. Amer. Chem. Soc.*, 1931, **53**, 1367.

[6] E. Hückel, *Z. Physik.*, 1930, **60**, 423.

[7] M. Dunkel, *Z. Physikal Ch.* (B), 1930, **7**, 81.

[8] W. G. Penney, *Proc. Roy. Soc.*, 1934, **144**, 166; *Proc. Phys. Soc.*, 1934, **46**, 333.

[9] W. G. Penney and G. B. B. M. Sutherland, *J. Chem. Phys.*, 1934, **2**, 492.

[10] P. C. Henriquez, *Chem. Weekblad.*, 1934, **31**, 2. E. Hertel, *Z. Elektrochem.*, 1934, **40**, 405. H. Mark, *Ibid.*, 1934, **40**, 421.

and at some low temperature there will be points where the kinetic energy is zero (A, B, C and D). The rotation is then no more fully developed, and the points A, B, C and D represent inversion points. There will be now only oscillations about the minima *a* and *b*. As all the molecules do not have the same "temperature" at any instant of time, there will be a mixture of molecules with small oscillations, with large oscillations, and with fully developed rotation. The intra-molecular rotations will be quantised. The lower the temperature becomes the more the molecules with small oscillations will predominate; quantitatively this can be expressed by the Maxwell-Boltzmann law of distribution. If the average oscillations about *a* and *b* are very small, we can speak of two isomers, "rotation isomers", the one characterised by the minimum *a* and the other by the minimum *b*. The velocity with which these isomers can pass into one another is determined by the energy levels *c* and *d*, and the equilibrium between them by the energy difference $\triangle U$ between *a* and *b*.

### STERIC FORCES.

Steric force is a better and more precise name given to the organic chemist's mechanical concept of steric hindrance. From a large amount of systematic and semi-quantitative work,[2] chemists have come to the conclusion that in ortho-substituted diphenyl derivatives, the rotation of the two benzene rings is restricted not by the number but by the size of the substituents. The dipole moments of a series of simple di-substituted diphenyl derivatives have been recently measured[11] in order to study quantitatively the nature and degree of restriction of rotation. Weissberger[12] believes that London forces of attraction between substituents even though of the same sign, come into play when they are near enough together, and thus contribute to the restriction of rotation. The question, however, is complicated on account of the still unknown nature of electronic shifts from one ring to the other. The existence of yet another reason for the reduction of freedom of rotation in the diphenyls will be referred to later.

Another case of restriction of free rotation by steric forces is to be found in compounds of the type $Ca_4$, where *a* is a non-axial symmetric substituent of the type $CH_2OH$, $OC_2H_5$, $CH_2ONO_2$, $CH_2Br$, etc. If a complete free rotation of such substituents about the four tetrahedral valencies of the central carbon atom were possible, then the moment of the molecule will not be zero but will have a definite value[13] given by $\sqrt{4\mu^2_k} = 2\mu_k$ where $\mu_k$ is the component of the group moment perpendicular to the axis of rotation. However since some of the compounds like $C(CH_2Br)_4$ have zero moment, and the moments of the other compounds do not change with temperature, it is generally concluded that due to lack of space for complete rotation or to the high intra-molecular fields, the groups in these molecules do not freely rotate but take up definite oriented positions.[14]

It would appear that free rotation is also annulled in the crystal state. The magnetic susceptibility measurements of Krishnan[15] and X-ray studies of Hertel[16] have shown that in di-, ter- and quater-phenyls, the benzene rings all lie in one line fixed in definite relative positions in the same plane. This phenomenon of fixing the rings in the crystal state shows interesting possibilities.[17] Thus, *m m′* diphenyl, although it cannot occur as stable *cis* and *trans* isomers can be fixed by suitably crystallising the substance in these two isomeric forms. Probably on account of the still feeble forces between the two *m m′* substituents a *trans* form will be more exclusively obtained; but a 3 3′ 5 5′ tetra substitued compound should be capable of being more easily fixed in the two isomeric forms. Such an isomerism would belong to the type called "crystal lattice isomerism", that has been particularly studied by Hertel[18] and others in a different case of inter-molecular compounds.

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[11] A. Weissberger and S. Sangewald, *Z. Physikal Ch.* (B), 1933, **20**, 145; *Trans. Farad. Soc.*, 1934, **30**, 884.
E. Naeshagen, *Z. Physikal Ch.* (B), 1934, **25**, 157.

[12] A. Weissberger, *Trans. Farad. Soc.*, 1934, **30**, 852.

[13] W. Hückel, *Z. Physikal Ch.* (B), 1929, **2**, 451. C. T. Zahn, *Physical Z.*, 1932, **33**, 400.

[14] L. Ebert, *Leipziger Vortrage*, 1929, 65.

[15] K. S. Krishnan, B. C. Guha, and S. Banerjee, *Phil. Trans. Roy. Soc.* (A), 1933, **231**, 235.

[16] E. Hertel and G. H. Romer, *Z. Physikal Ch.* (B), 1933, **21**, 292; **23**, 226.

[17] E. Hertel, *Z. Elektrochem.*, 1934, **40**, 407.

[18] E. Hertel, *Z. Elektrochem.*, 1931, **37**, 536.
E. Hertel and G. H. Romer, *Z, Physikal Ch.* (B), 1932, **19**, 288.

Interesting in this connection is the problem of restricted rotation about a single bond in a closed ring which does not seem to have been submitted to theoretical or otherwise quantitative investigations. Sachse[19], and Mohr[20] have postulated a restricted rotation in the cyclohexane ring so that an alternation between the *cis* and *trans* forms of this compound is possible. From his electron interference measurements Wierl[21] concludes that cyclohexane is an equilibrium mixture of the *cis* and *trans*, or what are more picturesquely called boat and chair forms. The measurements by O. Hassel[22] of the dipole moments of cyclohexane derivatives have yielded no definite conclusions. Le Fevre,[22] however, regards that the observed moment of 1 : 4 cyclohexadione is in agreement with a dynamic equilibrium between the *cis* and *trans* forms: and K. L. Wolf[23] has sought to explain the very high negative Kerr constant (–713) of paraldehyde on the basis of the *cis* and *trans* forms of the molecule.

## MULTIPLE BONDS.

The power of the double bond between carbon and carbon, or carbon and nitrogen to completely hinder free rotation about it so that only two stable equilibrium positions exist *cis* and *trans*, or *syn* and *anti*, is well known. The precise electronic mechanism which prevents the free rotation about the double bond has been worked out by Mullikan,[3] Hückel[6] and Penney[8]. However, on account of the considerable polarisability of the double bond compared to a single bond, this restricting power of the double bond is susceptible to strong modifications by the presence of substituents. The power for each specific case can be expressed in the shape of a potential energy-angle of rotation curve, which will have a form shown in Fig. 2 with two deep and sharp minima 180° apart. The height of the energy barrier between them could be calculated theoretically for some simple cases,[8] or derived from various physical measurements. Thus from a study of reaction kinetics, in the case of the fumaric and maleic acids Höjendahl[24] found a value of 15·8 k. cal. per mol. and in the case of dimethyl maleate and fumarate

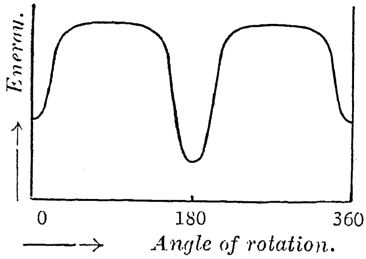


**Fig. 2.**

Nelles and Kistiakowsky[25] found a value 26·5 k. cal. Again from the fundamental twisting frequency for ethylene[26] the value of the energy barrier between the *cis* and *trans* forms could be estimated[27] to be about 30 k. cal. Ebert and Bull[28] find that at a temperature of 300°C., this energy barrier could be crossed over in the case of the symmetrical dichlor ethylenes. It was also observed that the *cis* form was the more stable of the two, the equilibrium mixture at this temperature consisting of 65% *cis* and 35% *trans*, and the energy difference between the two was estimated as 530 cal./mol. Although this result is contrary to what one would expect from the dipole forces alone, when other influences are taken into consideration[29] such as the London attraction (dispersion effect) between the substituent atoms, and the polarisation of the double bond by the strong field density produced by them in the *cis* position (induction effect), it could be shown that the observations stand theoretically supported. In as much as the induction effect on the double bond for the *cis* compound is very pronounced, it will be interesting to co-relate this with the observed[30] differences in the intensity and magnitude of the C=C frequencies given by the Raman spectra of these two isomers.

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[19] H. Sachse, *Z. Physikal Ch.*, 1892, **10**, 203; *Ber.*; 1890, **23**, 1365.

[20] E. Mohr, *J. Praklisch Ch.*, 1918, **98**, 315.

[21] R. Wierl, *Ann. der Physik.*, 1931, **8**, 559; 1932, **13**, 453.

[22] O. Hassel, *Trans. Farad. Soc.*, 1934, **30**, 876. R. J. W. Le Févre, *Ibid.*, p. 874.

[23] K. L. Wolf, *Leip. Vortrage*, 1929, 129.

[24] K. Höjendahl, *Z. Phys. Chem.*, 1924, **28**, 758.

[25] M. Nelles and G. B. Kistiakowsky, *J. Amer. Chem. Soc.*, 1932, **54**, 2208; *Z. Physikal Chem.*, 1931, Bodenstein Band, 369.

[26] A. Eucken and A. Parts, *Z. Physikal Ch.* (B), 1933, **20**, 192.

[27] W. G. Penney, *Proc. Phys. Soc.*, 1934, **46**, 333.

[28] L. Ebert and R. Bull, *Z. Physikal Ch.* (A), 1931, **152**, 451.

[29] H. A. Stuart, *Physikal Z.*, 1931, **32**, 793.

[30] Bonino and Brul, *Z. Phys.*, 1929, **58**, 194. M. Pestemer, *Wiener Ber.*, IIA, 1930, **139**, 667.

### ENERGY TROUGHS.

In contrast to the double bond the charge distribution in a single bond has a rotation symmetry, and a completely unhindered free rotation should be expected provided there is no interaction between the substituents or between the substituents and the carbon atoms. This ideal case is almost non-existent in the whole field of organic chemistry. Thus Penney[8] has shown that even in the simplest case of ethane, both by the H-L-P-S, and H-M methods of approximation, there will be free rotation of the $CH_3$ groups around the C-C axis *only* if the interactions of any H atom with the distant C and H atoms are neglected. When, however, the H-H interactions are allowed for, the azimuth $\phi$ around the C-C axis of one $CH_3$ group with respect to the other will appear implicitly in the H-H exchange integrals, and the energy will be no more independent of $\phi$. The general form of the energy curve can have a number of maxima and minima or energy troughs. Koenig[31] has considered the dynamics of a very general case where the potential field has $n$ maxima and minima in the range $0 \leqslant \phi \leqslant 2\pi$; and, Eyring[32] has calculated the complete shape of the curve for the case of ethane, and finds three maxima corresponding to three paired hydrogen positions and the accompanying three minima corresponding to the *trans* positions of the hydrogen atoms. The separating energy wall is only 350 cal./mol. so that at room temperature, where the mean energy $RT \sim 600$ cal./mol. the molecule can go from one trough to another and execute a complete rotation. But if the temperature is lowered this should be no more possible, and the molecule can perform only oscillations about the energy minima. Eucken and Weigert[33] have been actually able to show from measurements of molar heat over a large range of temperatures down to 143°T, that at low temperatures ethane behaves as a restricted one dimensional rotator, performing only oscillations about a minimum energy point. If a complete free rotation were possible then at these low temperatures, where the other inner degrees of freedom are not yet developed, the specific heat should be $6+1=7$ calories, while actually it is of the order 7·4: this excess is due to the oscillatory motion which has two degrees of freedom one for the potential energy and another for the kinetic energy. By a simultaneous comparison with the specific heat of ethylene, where there is no inner rotation possible, the increase in specific heat over a free rotating model can be quantitatively accounted for if the potential energy barrier is taken as 350 cal./mol. a value which agrees beautifully with that calculated by Eyring. At room temperatures only about 50% of the molecules have any inner rotation, and among them 45% have quantum number 1 (*i.e.*, oscillation) and 5% quantum number 2 (*i.e.*, free rotation).

In the case of substituted ethanes, the energy curve will be more complicated, the energy minima being of different depths and occupying different positions. An instance where this curve has been worked out in some detail is that of symmetrical dichlorethane.[34] The calculated relation between the distribution of the molecule into its various energy levels, and the effective dipole moment at different temperatures,[35] has been substantiated by careful experimental work,[36] and *vice versa*, from the experimental values of moment, the magnitude of the intra-molecular forces have been estimated. A considerable volume of work has been turned out regarding the possible degrees of rotation inside molecules and their bearing on the observed dipole moments, ever since the first papers on this subject were published by Höjendahl and Williams.[37]

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[31] H. D. Koenig, *Phys. Rev.*, 1933, **44**, 657.

[32] H. Eyring, *J. Amer. Chem. Soc.*, 1932, **54**, 3191.

[33] A. Eucken and K. Weigert, *Z. Physikal Ch.* (B), 1933, **23**, 265.
C. Wagner, *Ibid.* (B), 1931, **14**, 166.
L. Ebert, *Leip. Vortrage*, 1929, **44**.

[34] E. H. L. Meyer, *Z. Physikal Ch.* (B), 1930, **8**, 27.
C. P. Smyth, R. W. Dornte and E. B. Wilson, *J. Am. Chem. Soc.*, 1931, **53**, 4242.

[35] S. Mizushima and K. Higashi, *Proc. Imp. Acad., Tokyo*, 1932, **8**, 482.
J. E. Lennard Jones and H. H. M. Pike, *Trans. Farad. Soc.*, 1934, **30**, 830.
J. M. Sturtevant, *J. Am. Chem. Soc.*, 1933, **55**, 4478.

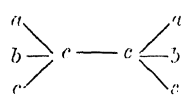
[36] E. W. Greene and J. W. Williams, *Phys. Rev.*, 1932, **42**, 119.
M. A. Govinda Rau and B. N. Narayanaswamy, *Proc. Ind. Acad. Sci.*, 1934, **1**, 14.
S. Mizushima and K. Higashi, *loc. cit.*

[37] J. W. Williams, *Z. Physikal Ch.*, 1928, **138**, 75.
K. Höjendahl, *Physical Z.*, 1929, **30**, 391.
C. T. Zahn, *Ibid.*, 1932, **33**, 400, 529, 730, 1933, **34**, 570.
C. P. Smyth and S. E. Kammerling, *J. Am. Chem. Soc.*, 1931, **53**, 2988.
P. C. Henriquez, *loc. cit.*

The existence of oscillations about a position of minimum energy has also been substantiated by X-ray interference diagrams.[38] Evidences for such positions of minimum energy seem also to be obtained from the Raman spectra of a number of molecules, and are neatly marshalled out in one of Kohlrausch's recent reviews.[39] However, the possibilities of these physical measurements to yield more quantitative informations regarding the intra-molecular rotation, have not been completely investigated.

When the two rotating parts are sufficiently separated as by introducing a benzene ring between them, the energy barriers can be smoothed down, and complete rotations made possible: such instances are to be found in *p*-xylylene dichloride, *p*-quinone dimethyl ether, etc.[40]

If there are more than one substituent in each of the methyl groups of ethane, there will be in general three pronounced energy minima, with appreciable energy barriers, and at low temperatures there will be a mixture of three rotation isomers, characterised by three equilibrium positions. Wolf[41] has shown that such rotation isomers exist in the case of tartaric acid and dibenzyl derivatives, which are symmetrically substituted ethane compounds of the type



In the meso form of these compounds the substituents *a*, *b* and *c* are so placed that all three can simultaneously occur in the *cis* or *trans* positions, while in the optically active form they cannot do so. If a complete free rotation were possible about the C–C link, both forms of the molecule will have identical moment. As this is not the case, and the active form has in general a higher moment (at the ordinary temperatures) than the meso form, it is obvious that in the latter the molecule tends to get fixed more in the completely *trans* position. Thus at T=0, the meso form will be fixed in this position, and the moment will be zero, while for the active form the moment will be a finite value—(since all *trans* positions cannot simultaneously occur). As the temperature is increased, on account of the fact that in the meso all the *cis* positions are simultaneously possible, the moment will reach a higher maximum than the *cis*, and the two curves representing moment *vs.* temperature will be separate and cross each other at some particular point. If we regard each form to consist of three isomers in equilibrium, with different optical rotations, then as the temperature rises the ratios between the isomers will shift and thus also the total optical rotation. Now, Lucas[42] has shown that in order that the rotation *vs.* temperature curve should have a maximum there should be at least three isomers present. In the case of ethyl tartrate an actual maximum has been observed. Further measurements on change of rotation with concentration also support the existence of three isomers. These evidences are, however, not altogether quantitative, as the influence of solvent, etc., have also to be taken into consideration.

Recent ideas regarding several possible canonical structures for one and the same molecule existing in a state of quantum mechanical resonance[43] have raised interesting possibilities, as certain bonds which are single in the ordinary structures are double in some others and thus acquire in part the properties of a double bond and *vice versa*. Problems connected with this have been recently discussed by Sutton[44] and Zahn[45]. Sidgwick[46] has, however, questioned the validity of some of the assumptions made although they may be mathematically correct. Another result of the resonance or the interference between the electronic clouds of a pair of singly linked atoms is the possibility of preferred angular positions, such as the highly unsymmetrical skew structures postulated by Penney and Sutherland[27] for $H_2O_2$ and $N_2H_4$.

An interesting possibility of the intramolecular rotation is the resulting shape of long chain molecules containing a series of C—C links. If there are two dipoles, each of moment *m*, at the two ends, one end

[38] F. Erhardt, *Physikal Z.*, 1932, **33**, 605.

[39] K. W. F. Kohlrausch, *Naturwiss.*, 1934, **22**, 166. *Z. Physikal Ch.* (B), 1932, **18**, 61.

[40] A. Weissberger and R. Sangewald, *Physikal Z.*, 1929, **30**, 792.

[41] K. L. Wolf and W. Bodenheimer, *Zeit. Physik. Chem.*, 1931, Bodenstein band, 620.

[42] R. Lucas, *Trans. Farad. Soc.*, 1930, **26**, 418.

[43] L. Pauling and J. Sherman, *J. Chem. Physics*, 1933, **1**, 606, 679.

[44] L. E. Sutton, *Trans. Farad. Soc.*, 1934, **30**, 789.

[45] C. T Zahn, *Ibid.*, 1934, **30**, 804.

[46] N. V. Sidgwick, *Ibid.*, 1934, **30**, 821.

ENERGY TROUGHS.

In contrast to the double bond the charge distribution in a single bond has a rotation symmetry, and a completely unhindered free rotation should be expected provided there is no interaction between the substituents or between the substituents and the carbon atoms. This ideal case is almost non-existent in the whole field of organic chemistry. Thus Penney[8] has shown that even in the simplest case of ethane, both by the H-L-P-S, and H-M methods of approximation, there will be free rotation of the $CH_3$ groups around the C-C axis *only* if the interactions of any H atom with the distant C and H atoms are neglected. When, however, the H-H interactions are allowed for, the azimuth $\phi$ around the C-C axis of one $CH_3$ group with respect to the other will appear implicitly in the H-H exchange integrals, and the energy will be no more independent of $\phi$. The general form of the energy curve can have a number of maxima and minima or energy troughs. Koenig[31] has considered the dynamics of a very general case where the potential field has $n$ maxima and minima in the range $0 \leqslant \phi \leqslant 2\pi$; and, Eyring[32] has calculated the complete shape of the curve for the case of ethane, and finds three maxima corresponding to three paired hydrogen positions and the accompanying three minima corresponding to the *trans* positions of the hydrogen atoms. The separating energy wall is only 350 cal./mol. so that at room temperature, where the mean energy $RT \sim 600$ cal./mol. the molecule can go from one trough to another and execute a complete rotation. But if the temperature is lowered this should be no more possible, and the molecule can perform only oscillations about the energy minima. Eucken and Weigert[33] have been actually able to show from measurements of molar heat over a large range of temperatures down to 143°T, that at low temperatures ethane behaves as a restricted one dimensional rotator, performing only oscillations about a minimum energy point. If a complete free rotation were possible then at these low temperatures, where the other inner degrees of freedom are not yet developed, the specific heat should be $6+1=7$ calories, while actually it is of the order $7 \cdot 4$: this excess is due to the oscillatory motion which has two degrees of freedom one for the potential energy and another for the kinetic energy. By a simultaneous comparison with the specific heat of ethylene, where there is no inner rotation possible, the increase in specific heat over a free rotating model can be quantitatively accounted for if the potential energy barrier is taken as 350 cal./mol. a value which agrees beautifully with that calculated by Eyring. At room temperatures only about 50% of the molecules have any inner rotation, and among them 45% have quantum number 1 (*i.e.*, oscillation) and 5% quantum number 2 (*i.e.*, free rotation).

In the case of substituted ethanes, the energy curve will be more complicated, the energy minima being of different depths and occupying different positions. An instance where this curve has been worked out in some detail is that of symmetrical dichlorethane.[34] The calculated relation between the distribution of the molecule into its various energy levels, and the effective dipole moment at different temperatures,[35] has been substantiated by careful experimental work,[36] and *vice versa*, from the experimental values of moment, the magnitude of the intra-molecular forces have been estimated. A considerable volume of work has been turned out regarding the possible degrees of rotation inside molecules and their bearing on the observed dipole moments, ever since the first papers on this subject were published by Höjendahl and Williams.[37]

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31 H. D. Koenig, *Phys. Rev.*, 1933, **44**, 657.

32 H. Eyring, *J. Amer. Chem. Soc.*, 1932, **54**, 3191.

33 A. Eucken and K. Weigert, *Z. Physikal Ch.* (B), 1933, **23**, 265.
C. Wagner, *Ibid.* (B), 1931, **14**, 166.
L. Ebert, *Leip. Vortrage*, 1929, **44**.

34 E. H. L. Meyer, *Z. Physikal Ch.* (B), 1930, **8**, 27.
C. P. Smyth, R. W. Dornte and E. B. Wilson, *J. Am. Chem. Soc.*, 1931, **53**, 4242.

35 S. Mizushima and K. Higashi, *Proc. Imp. Acad., Tokyo*, 1932, **8**, 482.
J. E. Lennard Jones and H. H. M. Pike, *Trans. Farad. Soc.*, 1934, **30**, 830.
J. M. Sturtevant, *J. Am. Chem. Soc.*, 1933, **55**, 4478.

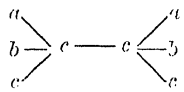
36 E. W. Greene and J. W. Williams, *Phys. Rev.*, 1932, **42**, 119.
M. A. Govinda Rau and B. N. Narayanaswamy, *Proc. Ind. Acad. Sci.*, 1934, **1**, 14.
S. Mizushima and K. Higashi, *loc. cit.*

37 J. W. Williams, *Z. Physikal Ch.*, 1928, **138**, 75.
K. Höjendahl, *Physical Z.*, 1929, **30**, 391.
C. T. Zahn, *Ibid.*, 1932, **33**, 400, 529, 730, 1933, **34**, 570.
C. P. Smyth and S. E. Kammerling, *J. Am. Chem. Soc.*, 1931, **53**, 2988.
P. C. Henriquez, *loc. cit.*

The existence of oscillations about a position of minimum energy has also been substantiated by X-ray interference diagrams.[38] Evidences for such positions of minimum energy seem also to be obtained from the Raman spectra of a number of molecules, and are neatly marshalled out in one of Kohlrausch's recent reviews.[39] However, the possibilities of these physical measurements to yield more quantitative informations regarding the intra-molecular rotation, have not been completely investigated.

When the two rotating parts are sufficiently separated as by introducing a benzene ring between them, the energy barriers can be smoothed down, and complete rotations made possible: such instances are to be found in *p*-xylylene dichloride, *p*-quinone dimethyl ether, etc.[40]

If there are more than one substituent in each of the methyl groups of ethane, there will be in general three pronounced energy minima, with appreciable energy barriers, and at low temperatures there will be a mixture of three rotation isomers, characterised by three equilibrium positions. Wolf[41] has shown that such rotation isomers exist in the case of tartaric acid and dibenzyl derivatives, which are symmetrically substituted ethane compounds of the type



In the meso form of these compounds the substituents *a*, *b* and *c* are so placed that all three can simultaneously occur in the *cis* or *trans* positions, while in the optically active form they cannot do so. If a complete free rotation were possible about the C–C link, both forms of the molecule will have identical moment. As this is not the case, and the active form has in general a higher moment (at the ordinary temperatures) than the meso form, it is obvious that in the latter the molecule tends to get fixed more in the completely *trans* position. Thus at $T=0$, the meso form will be fixed in this position, and the moment will be zero, while for the active form the moment will be a finite value—(since all *trans* positions cannot simultaneously occur). As the temperature is increased, on account of the fact that in the meso all the *cis* positions are simultaneously possible, the moment will reach a higher maximum than the *cis*, and the two curves representing moment *vs.* temperature will be separate and cross each other at some particular point. If we regard each form to consist of three isomers in equilibrium, with different optical rotations, then as the temperature rises the ratios between the isomers will shift and thus also the total optical rotation. Now, Lucas[42] has shown that in order that the rotation *vs.* temperature curve should have a maximum there should be at least three isomers present. In the case of ethyl tartrate an actual maximum has been observed. Further measurements on change of rotation with concentration also support the existence of three isomers. These evidences are, however, not altogether quantitative, as the influence of solvent, etc., have also to be taken into consideration.

Recent ideas regarding several possible canonical structures for one and the same molecule existing in a state of quantum mechanical resonance[43] have raised interesting possibilities, as certain bonds which are single in the ordinary structures are double in some others and thus acquire in part the properties of a double bond and *vice versa*. Problems connected with this have been recently discussed by Sutton[44] and Zahn[45]. Sidgwick[46] has, however, questioned the validity of some of the assumptions made although they may be mathematically correct. Another result of the resonance or the interference between the electronic clouds of a pair of singly linked atoms is the possibility of preferred angular positions, such as the highly unsymmetrical skew structures postulated by Penney and Sutherland[27] for $H_2O_2$ and $N_2H_4$.

An interesting possibility of the intramolecular rotation is the resulting shape of long chain molecules containing a series of C—C links. If there are two dipoles, each of moment *m*, at the two ends, one end

[38] F. Erhardt, *Physikal Z.*, 1932, **33**, 605.

[39] K. W. F. Kohlrausch, *Naturwiss.*, 1934, **22**, 166. *Z. Physikal Ch.* (B), 1932, **18**, 61.

[40] A. Weissberger and R. Sangewald, *Physikal Z.*, 1929, **30**, 792.

[41] K. L. Wolf and W. Bodenheimer, *Zeit. Physik. Chem.*, 1931, Bodenstein band, 620.

[42] R. Lucas, *Trans. Farad. Soc.*, 1930, **26**, 418.

[43] L. Pauling and J. Sherman, *J. Chem. Physics*, 1933, **1**, 606, 679.

[44] L. E. Sutton, *Trans. Farad. Soc.*, 1934, **30**, 789.

[45] C. T Zahn, *Ibid.*, 1934, **30**, 804.

[46] N. V. Sidgwick, *Ibid.*, 1934, **30**, 821.

moment can set itself in any direction independent of the other, and the resulting moment of the molecule will be $\sqrt{2}\ m$ irrespective of the number of links above a certain limit. This has been experimentally observed.[47] Recently Kuhn[48] has calculated the shape of such molecules to be that of a bean the ratio of whose axes are 6 : 2·3 : 1. Further the electron interference measurements with 1,5-dichlorpentane[49] show that in this case the distance between the end chlorine atoms cannot be defined.

Much of the above review shows how general is the phenomenon of intra-molecular rotation and how our ideas about it are still very qualitative. There is certainly ample scope for precise and quantitative investigations in this field.

## Study of Plant Tissue Fluids.*

By B. N. Sastri, M.Sc., A.I.C. and M. Sreenivasaya, B.A., F.I.I.Sc.

*Indian Institute of Science, Bangalore.*

### CHEMICAL INVESTIGATIONS.

A CHEMICAL study of the plant sap usually consists of a proximate analysis of the more important constituents, like total solids, total ash, total and amino nitrogens, sugars and ash constituents particularly P, K and Ca. In special cases, a determination of some definite constituent pertinent to the investigation, is carried out. In a study of the nature of rust resistance in wheat, Newton and Anderson[114] have determined the phenol content in the press juice of wheat plants varying in rust resistance. Link and others[115] have determined protocatechuric acid in the pigmented variety of onions, which is reputed to resist the fungus disease known as the onion smudge. Power and Chesnut[116] have examined the odorous constituents of the cotton plant, ammonia and trimethyl amine as the possible attractants of the boll-worm. Those varieties of cotton whose content of these constituents is low, are the ones more resistant to the attack of the boll-worm.

For most of the routine estimations, the centrifuged sap can be directly employed but for the estimation of certain constituents like sugars, phenols. a suitable method of clarification has to be adopted, with a view to eliminate substances interfering with the reaction. Immiscible solvents like ether or chloroform can be employed for extracting the constituent from the sap; sometimes a preliminary separation of the associated impurities by precipitating them out with a miscible solvent like alcohol or acetone facilitates subsequent processes of purification. This is elegantly achieved by absorbing the sap on a filter pad or pulp[117] and extracting the impregnated mass with alcohol or acetone.

There are other physical methods of fractionating the sap into groups of constituents, which are helpful in the isolation of certain constituents; ultra-filtration, for example, will effect a separation of the sap roughly into two portions, the filtrate containing mostly the crystalloidal constituents of the tissue fluid. The advantage of such a fractionation lies in the fact that both the ultra-filtrate and the residue are obtained in a "pure" state without any admixture of adsorbents, solvents or salts. Electro-ultra-filtration also can be employed with advantage in many instances, to ensure a greater rapidity of separation. The application of such colloid chemical technique has not been extensively employed in a study of the plant tissue fluids.

A line of investigation which has received little attention is the assay of the tissue fluids from the viewpoint of its dynamic nature. It is determined by the presence of the reactive groups on the one hand, and the agents catalysing certain reactions on the other. The reactive groups, aldehydic, ketonic, amino, sulphydryl, hydroxyl, phenolic, carboxyl, can easily be estimated chemically while the existence of the biochemical catalysts present in the fluid is

47 L. Ebert and K. Höjendahl, *Z. Physikal. Ch.* (B), 1932, **15**, 74.

48 W. Kuhn, *Koll. Z.*, 1934, **68**, 2.

* Continued from *Curr. Sci.* 1934, **3**, 58.

114 Newton and Anderson, *Can. J. Res.*, 1929, **1**, 85.

115 Link *et al*, *J. Biol. Chem.*, 1929, **81**, 369.

116 Power and Chesnut, *J. Amer. Chem. Soc.*, 1925, **47**, 1751.

49 R. Wierl, *Ann. der Phys.*, 1931, **8**, 521.

117 Sreenivasaya and Sastri, *J.C.S.*, *abst.*, 1931, **A**, 1342.

revealed through a study of the enzyme make up of the sap.[118, 119]

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Colloid chemical studies of plant tissue fluids open out a new field of investigation. The most comprehensive investigation which has been conducted is in connection with the study of drought resistance[52] and winter hardiness[6, 53, 54, 55] in plants. Particular attention should be drawn to the systematic work of Gortner, Newton and others in the field. Newton[120] has studied the gold number of colloids in plant tissue fluids in the course of dialysis. The question of hydration of colloids in plant juices is a problem which has aroused wide interest in the field of plant physiology and this important and extensive subject should be dealt with in a separate review.

[118] Sastri and Sreenivasaya, *Enzymes of the sandal leaf in health and disease* (unpublished).

[119] Votchel, *C.A.*, 1924, **18**, 2359.

[120] Newton and Martin, *Can. J. Res.*, 1930, **3**, 336.

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# The Origin of the Santra Orange.

By S. S. Bhat, M.Ag.

THE *Santra* orange is perhaps the most important table variety of citrus in India, its cultivation being chiefly concentrated in the Central Provinces and parts of Western India—more than 10,000 acres being under its cultivation in these tracts. It is a loose-skinned orange of the Tangarin type, and was for a long time accepted in this country as *Citrus aurantium*. The description of King orange (*Citrus nobilis*) of California seems to agree well with that of *Santra*. As there are other types of loose-skinned oranges like *Ladu* and *Kavla* growing in this country and closely related to *Santra*, it is difficult to say which of them is exactly the King orange. After a careful study of the various systems of classification of citrus fruits offered by different authors, Cheema and Bhat[1] have assigned to *Santra* the place and name of *Citrus nobilis*, Lour. var. *deliciosa* Swingle.

Like the other varieties of citrus, the *Santra* seems to have originated somewhere in Southern and Cochin China. Citrus varieties are even at present found in a wild state also at the foot of the Himalayas in the north-eastern part of India.[2] There are references to these fruits in the ancient Sanskrit literature. The very word *Santra* might have been derived from the Sanskrit word *sam* (सम्) meaning 'well', and *tri* (तृ) meaning, 'to float', the whole word '*Santra*' meaning one that floats well. The fruit floats very well indeed in water. The fruits were possibly observed coming to the southern parts floating in rivers from the wilds at the foot of the Himalayas. Hence the name *Santra* or the floating fruit seems to have been given to it in the earliest times as soon as it came to the notice of the ancient Sanskrit-knowing Aryans. The other word *Narangi*, which is another popular name of this fruit, is perhaps similarly derived. *Narangi* is a corruption of the word "Nagaranga" (नागरंग). *Naga* means red lead in Sanskrit. *Arangama* or *aranga* means one that becomes visible. Both these words on joining form the word *nagaranga*, and mean one that has the red lead colour and that becomes visible or floats. Both the words *santra* and *nagaranga* or *narangi* are descriptive. The application of descriptive words to objects in Sanskrit is almost universally traditional as in Latin. Further, names of oranges in the original Khasi languages are words like *Usoh niamtra*, *Usoh sim*, *Usoh mianger*, etc. These words do not seem to bear any relation to the word *santra*. However, it is perhaps possible to derive the word *santra* from the word *Usoh niamtra*. If the first letters of these two syllables '*U*' and '*ni*' are dropped, what remains comes to be '*soh*' and '*amtra*'. Now joining these two latter syllables, a word like '*sohamtra*', '*sontra*' or '*santra*' may be formed. Excepting this very doubtful likelihood, it seems, therefore, more probable that the word *santra* must have been a name given to the fruit by the Sanskrit-knowing Aryans. Bonavia suggests the derivation of the word *santra* from the word *Shans*, who were rulers in Assam about the beginning of the Christian era. This

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[2] Bonavia, E., "The cultivated oranges and lemons of India and Ceylon."

suggestion fits in well so far as the first part '*san*' is concerned. But how a syllable like '*tra*' came to be affixed is not at all explained. It seems therefore possible

(1) that these words *santra* and *narangi* were non-existing before the fruit was known to the Aryans. The Chinese and the Khasi languages have their own distinct vernacular names for these fruits;

(2) the fruit was existing in the north-eastern parts of India before the Aryans came there;

(3) the fruit must either be indigenous in the north-eastern parts of India, or it must have been introduced there from the neighbouring countries on the East, in prehistoric times.

## Letters to the Editor.

### Elimination of Bias due to Selection.

As correlation methods are being used nowadays to a much greater extent than before for forecasting, say, the rainfall or temperature at any place or even the amount of wheat grown in any particular area, a problem, which is often overlooked by forecasters, has become somewhat important. The problem arises in the following manner.

When we want to select some factors for forecasting a quantity, we often take a number of factors, correlate each of them with our forecasted quantity and select out of these factors two or more factors which give the highest C.C. (written in short for correlation coefficient) with our forecasted quantity. In testing these selected C.C.'s for significance, some forecasters apply the usual tests for significance, overlooking the fact that these tests are meant only for C.C.'s selected at random and not for C.C.'s so deliberately chosen as these. In these latter cases Walker's test[1] has to be applied.

Now, all that Walker's test tells us is whether our selected C.C.'s could have been obtained by mere random chance from populations of which the C.C. $\rho$ is zero. By "random chance" is meant here either Walker's level of significance, *viz.*, 50%, or the 5% level of significance suggested by R. A. Fisher. If the selected C.C.'s could not have been obtained by random chance from populations in which $\rho=0$, the C.C.'s are considered significant, and the selected factors are used to give a forecasting formula in the usual manner.

The forecaster is also very much interested to find out the approximate value of the C.C.'s of the various populations from which our selected C.C.'s are samples, in order to determine, at least qualitatively, the amount of reliance that he can place in his factors. For this purpose he will have to apply Normand's Performance Test.[2] Unfortunately he will have to wait for a number of years for the accumulation of data before he can use the Performance Test. As this Test is thus not of immediate use, a method has been discovered by which it is possible to eliminate the bias due to selection from each of the selected C.C.'s and thus get values which are the least values of the corresponding $\rho$'s of the populations either on Walker's or Fisher's level of significance. Full details of the method are given in a paper which will be published elsewhere. Only a gist will be given here.

Let $\rho$ be the C.C. of the population from which $m$ random samples of $n$ values each are drawn and let the C.C.'s be worked out for each sample. Suppose we select $(l+1)$ highest C.C.'s of which let the lowest value be $r_1$. Let $p$ be the chance of obtaining a C.C. numerically less than $r_1$ in a random sample of $n$ from the population. Then the chance of getting in the selected $(l+1)$ C.C.'s no C.C. which is numerically less than $r_1$, out of $m$ random C.C.'s is given by

$$P = 1 - (p^m + {}_mC_1 p^{m-1}q + {}_mC_2 p^{m-2}q^2 + \cdots + {}_mC_l\, p^{m-l}q^l) \cdots \quad \mathrm{I}$$

where $q = 1-p$.

Although equation I is of the $m$th degree, in $p$ it has only one real positive fractional root, which may be called the probability root. We can obtain the probability roots after putting $P = 0\cdot5$ and $0\cdot05$ in I. Let these roots be denoted by $p\ (0\cdot5)$ and $p\ (0\cdot05)$ respectively. We can now find the value of $\rho$ corresponding to $p\ (0\cdot5)$, $r_1$ and $n$. Let this value be denoted by $\rho\ (0\cdot5)$. Similarly we can find $\rho\ (0\cdot05)$. $\rho\ (0\cdot5)$ and $\rho\ (0\cdot05)$ are the *least* values of $\rho$'s of the

[1] G. T. Walker, *Mem. Ind. Met. Dept.*, 1914, **21**, 13-15; S. R. Savur and S. Gopal Rau, *Ind. Met. Dept., Sci. Notes*, **5**, No. 49.

[2] C. W. B. Normand, *Q. J. R. Met. Soc.*, 1932, **58**, 3-10; S. R. Savur, *Ind. Jour. Phy.*, **7**, Part 1, pp. 27-34.

populations on the 50% and 5% level of significance respectively, which gave us $(l+1)$ C.C.'s which are not numerically less than $r_1$ in $m$ random C.C.'s. These values will help the forecaster in forming a rough estimate of the amount of reliability he can place in his forecasts. As already mentioned above, more details will be given elsewhere.

S. R. SAVUR.

Meteorological Office,
Poona 5,
*September 14, 1934.*

## Rectification Phenomenon in Pyrolusite Crystal.

IN the course of our investigations on the crystal-and-point rectification, we found that when ordinary mineral pyrolusite ($MnO_2$) crystal was dipped into mercury, alternating current was rectified to a great extent. The source of the alternating current was a 1000 cycle alternator (microphone hummer). When tested with steady voltages, the current-voltage characteristic curve showed a marked asymmetry. A typical characteristic curve is shown in Fig 1. The resistances as calculated from the curve for different positive and negative voltages are also illustrated in the same figure. The rectification ratio which is taken as the ratio of the difference of the currents in the two opposite directions to the larger value of the current is also shown. The ratio decreased in this particular experiment with the applied voltage. The value was 50% for 2 volts.

The mercury used was cleaned after shaking it with dilute nitric acid in a mechanically shaking machine for eight hours. After subsequently washing it in running distilled water, the pyrolusite crystal on drying was mounted so as to dip into the clean mercury. The crystals such as galena (PbS), iron pyrites ($FeS_2$), bornite ($Cu_2S$, CuS, FeS), magnetite ($Fe_3O_4$), molybdenite ($MoS_2$) did not, however, show any such rectification effect, when similar experiments were performed under similar conditions.

It should be made clear that the rectification generally observed with these crystals in combination with a pointed metal is reduced to zero, when the contact area is large. The pyrolusite crystal dipped into mercury had, in our experiments, a very large contact area so that the effect observed could not be attributed to the ordinary crystal-and-point rectification. When the same pyrolusite crystal was held between two electrodes of large area, there was no such rectification effect.

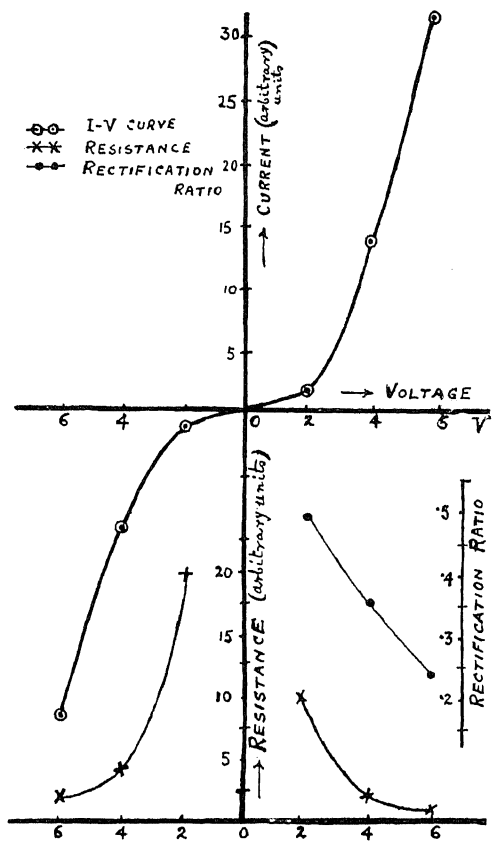


**Fig. 1.**

The cause of this rectification seems to be associated with the layer of air between the surface of the crystal and mercury. This is yet a subject of further investigation. Whatever be the cause, this promises to be of great practical use.

S. R. KHASTGIR.
ANIL KUMAR DAS GUPTA.

Physics Laboratory,
Dacca University,
*September 23, 1934.*

## The Band Systems of $CaCl_2$.

THE spectrum of the carbon arc fed with $CaCl_2$ has been measured on plates taken in the first order of a 21 ft. grating. These data together with those of Hedfeld* are utilised in analysing the bands. While

* *Zeit. für. Phys.*, 1931, **68**, 610.

there is excellent agreement between the data of Hedfeld and the present measurements. some of the bands measured by him do not really belong to the $CaCl_2$ molecule.

The bands consist of two systems one of which. the red system, is clearly due to the transition $^2\Pi \rightarrow {}^2\Sigma$. These involve *two* P and *two* Q heads and the system comprises only the $\Delta v=0$ and $-1$ sequences. The equation representing the $Q_1$ heads is:—

$$\nu = 16094\cdot6 + (363\cdot76\, v' - 1\cdot16\, v'^2 + 0\cdot0012\, v'^3) - (360\cdot81\, v'' - 1\cdot01 v''^2 - 0\cdot001\, v''^3).$$

The heats of dissociation for the $^2\Pi$ and $^2\Sigma$ states are found to be 4·60 and 3·46 volts respectively. This indicates that in the $^2\Pi$ state of the molecule is involved the anomalous $(4p)^2\ {}^3P$ term of the Ca atom. The $^2\Sigma$ state arises out of the $(4s\,4p)\ {}^3P^\circ$ term ot the Ca atom.

The other, orange system, involves evidently a $\Sigma - \Sigma$ transition. The final level of this system does not at all correspond to the final level of the red system. These bands degrade towards the shorter waves but the sequences degrade to the longer waves. Only two, $\Delta v = 0$ and $+1$ sequences are developed. The following equation represents the heads:—

$$\nu = 16847\cdot6 + (361\cdot38\, v' - 1\cdot68 v'^2 - 0\cdot015 v'^3) - (364\cdot51 v'' - 1\cdot46\, v''^2 - 0\cdot02 v''^3).$$

This gives for the heats of dissociation of the upper and lower states, 1·53 and 1·52 volts respectively. It can be shown that the upper $\Sigma$ state arises out of the $(4s\,5s)\ {}^3S$ term of the Ca atom and the lower from $(4s\,4p)\ {}^3P^\circ$ term of the Ca atom. This latter level should apparently be identical with the $^2\Sigma$ state of the red system. However, the discrepancy not only in the vibrational constants but also in the heats of dissociation points to a different $\Sigma$ level for the final state of the orange system. The ultra-violet system has not been dealt with.

Details will be published elsewhere.

R. K. Asundi.
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Aligarh,
*September 27, 1934.*

## Additional Bands in the Band System of Sulphur.

On measuring my plates of the emission bands of sulphur produced in a discharge tube containing sulphur vapour in the presence of Argon, a few bands not previously recorded, have been observed. No bands could be traced to wave-lengths higher than 6612·3 Å. All bands from this wave length down till 4136 Å possess in the main, three heads, the strongest of them agreeing in wave-lengths with those of such of the bands as are also recorded by Fowler and Vaidya.* The following newly recorded bands fit in the scheme of vibrational analysis given by these authors and thus form part of the already known system of the $S_2$ molecule:

| (v′v″) | $\lambda_{air}$ (int) | $\nu$ (vac) |
|---|---|---|
| 9,32 | 6612·3 (8) | 15119 |
| 8,31 | 6545·0 (7) | 15275 |
| 7,30 | 6476·3 (5) | 15437 |
| 9,31 | 6382·7 (10) | 15663 |
| 8,30 | 6316·7 (9) | 15827 |
| 7,29 | 6251·5 (8) | 15993 |

R. K. Asundi.
Physics Research Laboratories,
Muslim University,
Aligarh,
*September 27, 1934.*

## Influence of Dissolved Electrolytes on the Constitution of Water.

Ramakrishna Rao[1] has recently suggested that the changes with temperature in the distribution of the intensity of the three components of the Raman band of water at 3610 cm.$^{-1}$, 3413 cm.$^{-1}$ and 3195 cm.$^{-1}$ may be explained on the hypothesis that water consists of three types of molecules represented by $(H_2O)$, $(H_2O)_2$ and $(H_2O)_3$, to which are attributed the above three components, and the changes in the relative proportions of which bring about the above intensity changes. He also suggested that the effect of dissolved electrolytes on water may also result in the formation of hydrates by the association of the molecules of water with the ions of the solute.

The above hypothesis was put forward on the basis of work with only a few electrolytes at a few concentrations. With a view to investigate how far this is applicable in general to all electrolytes at a large number

* *Proc. Roy. Soc.*, 1931, **132A**, 310.

[1] *Proc. Roy. Soc.*, 1931, **130A**, 489.

of concentrations, the author has, by a study of the changes in the structure of the Raman band of water, made a systematic investigation of the behaviour and constitution of water under the influence of several typical electrolytes dissolved in it. The results, which appear to confirm the above hypothesis, are given below.

The Raman band for water in solutions of electrolytes is invariably sharper than for pure water, the maximum of the band being nearly in the same position as that attributed to the $(H_2O)_2$ molecules.

With aqueous solutions of the few electrolytes that dissolve up to 8N and above (nitric acid, sulphuric acid, sodium nitrate, lithium nitrate and chloride have been thus far studied), the band gets sharper with increasing concentration of the electrolyte and shifts as a whole towards greater frequency. Also the portion of the intensity curve for the water band on the smaller frequency side, attributed to the $(H_2O)_3$ molecules, becomes less convex with increasing proportion of the electrolyte.

With hydrochloric acid, however, an anomalous result was observed, the band being sharper at the lower concentration, 8N, than at 11·7N, the shift of the maximum of the band also being in the opposite sense to that observed in the other cases.

All these results go to indicate the extreme stability of the double molecules $(H_2O)_2$, and the comparative instability of the other two types, triple $(H_2O)_3$ and single $(H_2O)$, in solutions of electrolytes.

Whereas there is a progressive shift towards larger frequency in the water band in solutions of electrolytes at the same concentration, as we pass from lithium chloride to sodium nitrate and from hydrochloric acid to sulphuric and nitric acids, these differences tend to vanish when the water content in them, and not the amount of the electrolyte, is equalised. This observation goes to indicate that the change in water equilibrium between mono-, di- and trihydrol is the more probable cause of the effects observed, and the differences, though minor, that still persist at the same water content in the electrolytes studied may be either due to a change in the water equilibrium to different extents in the different cases, or to a difference of hydration in the several cases, or, what is more probable, to the simultaneous existence of both.

The cation appears to exert little influence on the behaviour of the solvent, as can be inferred from the similarity of results obtained with acids and salts.

The intensity curves of the water band in solutions of sodium nitrate are in general sharper than those for nitric acid, even when the latter is taken at a much higher concentration. This result may be partly due to the formation of more complex hydrates and partly due to the superposition of the $NO_2OH$ band at 3420 cm.$^{-1}$ on the band due to water in solutions of nitric acid.

The results obtained by the author, therefore, go to show that the effect of dissolved electrolytes on the constitution of water may be partly to change the water equilibrium between mono- di-, and trihydrol, and partly to cause an association of the water molecules with the ions of the solute resulting in the formation of hydrates, the extent and complexity of which seems to be different for different substances. With the work so far done it is difficult to say more exactly how far each of these effects contributes to the results observed. A detailed report of these investigations has been communicated to the *Indian Journal of Physics*.

C. SAMBASIVA RAO.

Andhra University,
Waltair,
*September, 1934.*

### Change of Resistance of Cobalt in Longitudinal Magnetic Fields.

DUE to the difficulty of obtaining the metal in suitable forms, a complete study of the change of resistance of cobalt in longitudinal magnetic fields had not been made so far. The transverse effect alone had been studied by earlier workers,[1] the metal being used in the form of thin films deposited on glass or some other surface. The only earlier worker who observed the longitudinal effect in cobalt was Paul McCorkle.[2] His curve for cobalt goes on increasing continuously and does not show any tendency to saturate even up to a field of about 1200 gauss. The resistance of nickel or iron increases in longitudinal magnetic fields, ultimately reaching a saturation value. This is a well-known fact verified by a host of observers, including McCorkle himself. His

[1] J. C. Beattie, *Phil. Mag.*, 1898, **45**, 243.
L. Grunmach, *Ann. der Phys.*, 1907, **22**, 141.

[2] P. McCorkle, *Phys. Rev.*, 1923, **22**, 271.

result for cobalt therefore is surprising and needs confirmation.

The writer has made a thorough study of the longitudinal effect in cobalt, using thin strips of the metal cut from a plate, certified by the makers to be of 95 per cent. purity. It has been found that the resistance does saturate, and also shows hysteresis. In the following table are given the values of the percentage change of resistance of cobalt in longitudinal magnetic fields. The magnetic field is increased gradually, and when there is no further change of resistance, the field is gradually decreased and brought back to zero. It is found that the resistance of the metal is now greater than the original resistance.

Table I.

| Increasing fields | Percentage change of resistance | Decreasing fields | Percentage change of resistance |
|---|---|---|---|
| 0·0 gauss | 0·0 | 0·0 gauss ↑ | 0·08 |
| 20 ,, | 0·07 | 20 ,, | 0·15 |
| 500 ,, | 0·36 | 75 ,, | 0·19 |
| 700 ,, | 0·43 | 440 ,, | 0·41 |
| 1020 ,, | 0·55 | 890 ,, | 0·54 |
| 1250 ,, | 0·58 | 1300 ,, | 0·58 |
| 1500 ↓ ,, | 0·58 | 1500 ,, | 0·58 |

The intensity of magnetisation in the specimens of cobalt was also measured and it was found that the maximum intensity was attained between 1200 and 1300 gauss. Thus it appears that the change of resistance saturates at the same time as the magnetisation. The change is always found to be an increase, as is evident from the above table. The writer has also been able to obtain the complete resistance-hysteresis cycle of cobalt in longitudinal magnetic fields. Full details will be published elsewhere.

This is for the first time that resistance-hysteresis has been observed in the case of cobalt. The fact that the increase of the resistance of cobalt saturates at the same time as the intensity of magnetisation, has also been observed for the first time.

The writer is indebted to the authorities of the Patna Science College for permission to carry on the investigation in the Physics Laboratory of the college, and the facilities afforded.

Md. Sharf Alam.

Physics Laboratory,
Science College,
Patna,
*October 3, 1934.*

## Smoke Pollution in Bombay.

This investigation of smoke pollution was undertaken on behalf of the Smoke Nuisances Commission, Bombay.

The following brief report (a fuller account with a new method of estimating the number of smoke particles will appear elsewhere) indicates the nature of variation in the number of smoke particles at various mill localities in Bombay.

Some observations were taken in dry weather in April while a few were made in monsoon in July on suitable rainy days. The results at each centre were taken both in the morning and in the evening.

*April Results.*

| | Ferguson Road | Byculla Bridge | Lalbaugh | Sewri |
|---|---|---|---|---|
| Morning | 2830 | 1930 | 2060 | 2940 |
| Evening | 3950 | 2990 | 3570 | 2780 |

*July Results.*

| | Ferguson Road | Byculla Bridge | Lalbaugh | Sewri |
|---|---|---|---|---|
| Morning | 2260 | 2380 | 2210 | 1260 |
| Evening | 3025 | 3050* | 2215 | 1740 |

*The number in each column represents the average number of smoke particles per c.c.

It is seen that on the whole the evening number of smoke particles is higher than the corresponding value in the morning.

There is a difference between the evening results of April and July, and excepting the result marked (*), it is clear that the average number reduces by about 1000 to 1200 per c.c. in monsoon. This number may be attributed to smoke other than that of mills. There is no uniform variation in the morning results of the two months indicating that in the morning there may not be smoke other than that of mills.

The results indicate that the number of smoke particles per c.c. varies between 1200 to 4000 per c.c.

I thank the Commission for the permission to publish these results.

Y. G. NAIK.

Physics Department,
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Bombay.
*September 1934.*

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### Dry Ether as Solvent for Anhydrous Aluminium Chloride in Organic Synthesis.

THE author has made the interesting observation that dry ether which has the remarkable property of readily dissolving anhydrous aluminium chloride can be advantageously used for some reactions of the Friedal-Crafts' type which take place under mild conditions, *i.e.*, at or below the boiling point of ether.

Anhydrous aluminium chloride when added to dry ether quickly dissolves with evolution of heat and a clear colourless solution results in which the aluminium chloride is present in the form of a double compound with ether, $AlCl_3$, $C_4H_{10}O$.[1] This solution can directly be used for synthesis.

The author observed that the condensation of benzanilide-imido-chloride with polyhydric phenols in the presence of aluminium chloride to give anils of polyhydroxybenzophenones, proceeds best with dry ether as solvent. Ichaporia, working in this laboratory, has also found the use of dry ether as solvent advantageous for Shah and Chaubal's synthesis of dialkylaminobenzophenones[2] in which a benzanilide-imido-chloride is condensed with an aromatic tertiary amine with aluminium chloride as condensing agent. It is also found that a solution of aluminium chloride in ether can be used in place of a suspension of zinc chloride in ether for the Hoesch synthesis, *e.g.*, for the preparation of 2: 4-dihydroxybenzophenone from benzonitrile and resorcinol. All of these reactions are carried out in cold ethereal solution.

Ether would appear to offer an obvious advantage over some of the usual diluents like carbon disulphide, benzene, petroleum ether, in which aluminium chloride is insoluble. With ether as solvent, the reaction can be carried out in homogeneous solution.

The principal drawback to the general use of ether for this purpose is its tendency to react in some cases in the presence of aluminium chloride, the carbon-oxygen bond in ether being broken. The mixture of benzoyl chloride and aluminium chloride reacts with ether to give ethyl benzoate[3]. Triphenyl chloromethane in the presence of aluminium chloride and ether gives triphenyl methyl ethyl ether, which further gives by decomposition triphenylmethane and acetaldehyde.[4] The action of ether and aluminium chloride on diphenyl-dichloromethane is stated by the same author[5] to give benzophenone. It may be pointed out, however, that it seems more likely that no reaction takes place in the last case, and that the formation of benzophenone might be due to simple hydrolysis of the easily hydrolysable diphenyldichloromethane on subsequent treatment with water. Ether has also been known to act as an ethylating agent in the presence of aluminium chloride, but this requires high temperatures. Thus Jannasch and Rathjen[6] obtained diethyl phenol by heating phenol, ethyl ether and aluminium chloride at 145°. They similarly prepared hexaethyl benzene from benzene, ethyl ether and aluminium chloride.[7]

A detailed account of the experiments above referred to will be published elsewhere.

Attention is directed to the author's observation in as much as it may find application in some of the numerous organic reactions requiring the use of aluminium chloride as a condensing agent, which take place at relatively low temperatures.

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Bombay,
*September, 1934.*

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### The Biological Oxidation of Inositol.

INVESTIGATIONS have been carried out on the oxidation of inositol *in vitro* by animal tissues. The wide occurrence of inositol in plant and animal tissues would suggest

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[1] *Cf.* Walker and Spencer, *J.C.S.*, 1904, **85**, 1106; Frankforter and Daniels, *J. Am. Chem. Soc.*, 1915, **37**, 2560.

[2] *J.*, 1932, 650.

[3] Norris, *J. Am. Chem. Soc.*, 1924, **46**, 2580.

[4] Norris, *loc. cit.*

[5] Norris, *loc. cit.*

[6] *Ber.*, 1899, **32**, 2391.

[7] *Ber.*, 1898, **31**, 1716.

that it has some important function which is not yet understood. We have carried out some experiments with the brain, heart, kidney and liver tissues of normal adult albino rats which have been fed on our standard mixed diet.

In the case of minced brain tissues, both washed and unwashed, inositol is oxidised. Minced heart muscle, also both washed and unwashed, gives an additional oxygen uptake with inositol. Kidney tissues have been studied, sliced as well as washed after mincing, and have been found to oxidise inositol. Liver tissues also appear to oxidise inositol though at a low rate.

The experiments were carried out with the Barcroft-Warburg apparatus in the usual way. The temperature of the thermostat was maintained at $37° \cdot 3 \pm 0 \cdot 1$. The medium in which the tissues were suspended consisted of phosphate buffer at pH 7.4 and Ringer-Locke solution.

B. C. Guha.
N. Das.

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Bengal Chemical and Pharmaceutical Works, Ltd.,
Calcutta,
*September 10, 1934.*

## A Preliminary Note on the Morphology of the Aerial and Underground Flowers of *Commelina benghalensis*, Linn.

Although a very common weed, *Commelina benghalensis* is of great interest because of the presence of underground flowers in addition to the normal aerial ones. In the Indo-Gangetic Plains, this plant usually makes its appearance in the month of July and dies down towards the close of October. An examination of the spathes reveals the fact that each has usually three flowers enclosed within it. One of these and the first to develop has a longer pedicel than the other two, and is purely male (Fig. 1). Of the other two, which are hermaphrodite, one opens in the usual way and is chasmogamous (Fig. 2 B), while the other remains closed and is therefore cleistogamous (Fig. 2 C). The first flower naturally sets no seed and soon withers and drops off (Fig. 2 A). Of the other two, the chasmogamous produces seeds first and the cleistogamous a little afterward. Only the former comes out of the spathe; the latter remains bathed in the slimy fluid secreted within the spathe.

Each flower has 3 perfect stamens of which one is yellow and is larger than the two laterals which have a sky-blue colour. In addition to these there are 2 or 3 staminodes which are sterile. In some cases a very few pollen grains have been seen in the anthers of the staminodes also, but it is not likely that they are of any use in fertilisation.

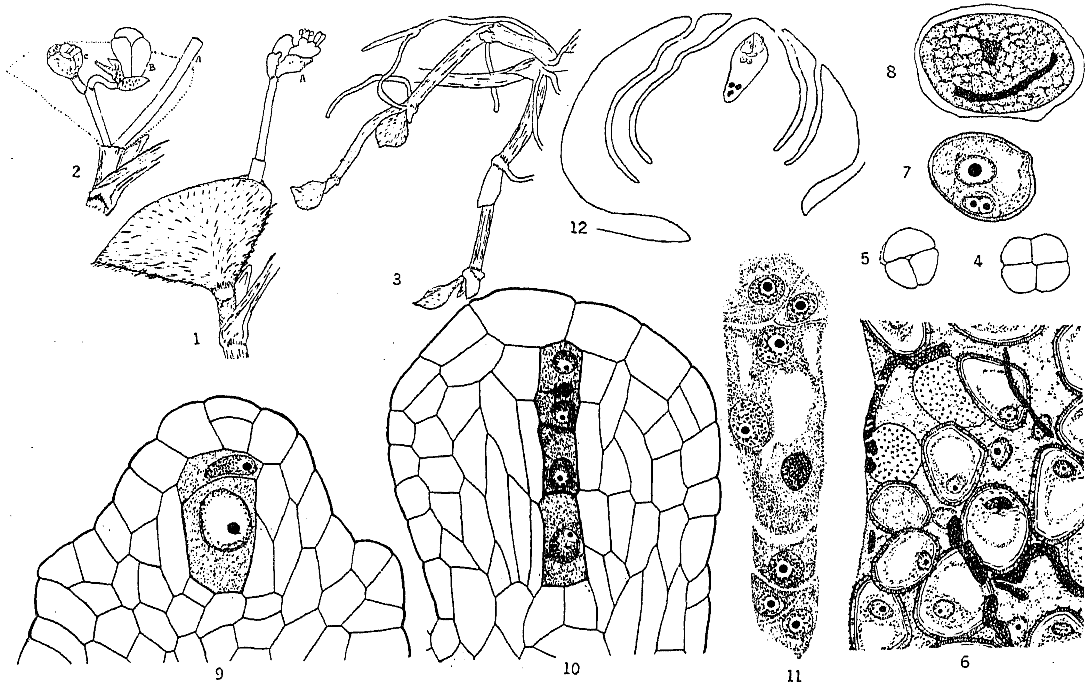
In addition to the blue aerial flowers mentioned above, every plant produces a large number of cleistogamous flowers borne on branches produced from the lower part of the stem (Fig. 3), which penetrate into the ground. While the aerial flowers occasionally fail to ripen, the underground ones are very fertile and the seeds are self-sown in the soil. A very similar condition has been reported by Hagerup[1] in *Commelina forskalei*.

The following account of the development of the gametophytes applies to both kinds of flowers, unless it is specially mentioned otherwise.

*Microsporogenesis.*—The early development of the anther presents no unusual features. The primary parietal layer divides periclinally to give rise to the endothesium, one middle layer and tapetum. The nuclear divisions in the latter are mitotic and the cells become binucleate at or even before the time of synizesis in the microspore mother cells. By the time the reduction divisions are over, the walls of the tapetal cells disorganise and the contents give rise to a true periplasmodium. It is noteworthy to record the presence of crystals of Calcium oxalate in the periplasmodium as also seen by Mascre[2] (1925) in *Tradescantia virginica* L. While they are not distinguishable in sections prepared according to the usual methods, they can be readily seen by crushing a fresh anther on a slide and examining it without any treatment whatever. At the microspore stage some rod-like bodies are also conspicuous in the periplasmodium (Fig. 6), but we have not been able to determine their exact nature so far. During the maturation of the male gametophyte, the nuclei of the tapetum begin to degenerate and finally the

[1] Hagerup, O., "On pollination in the extremely hot air at Timbucto," *Dansk. Bot. Arkiv.*, 1932, **8**, 1-20.

[2] Mascre, M., "Sur l'evolution de l'etamine des Commelinacees," *Bull. Soc. Bot., France*, 1925, **72**, 1060-1066.



**1.** Spathe enclosing 2 bisexual flowers and one staminate flower protruding out.

**2.** Same with spathe opened. The staminate flower at (A) has dropped off; of the two others, "B" is chasmogamous and "C" is cleistogamous.

**3.** Stalks bearing underground flowers and the fruits formed from them.

**4, 5.** Tetrads of microspores. × 310.

**6.** Part of a section of an anther showing the tapetal plasmodium and microspores. × 390.

**7.** Pollen grain with tube and generative cells. × 390.

**8.** Pollen grain with sickle-shaped generative nucleus and tube nucleus disorganised. × 390.

**9.** Nucellus with megaspore mother cell and primary wall cell. One of the epidermal cells has also divided periclinally. × 390.

**10.** Nucellus with tetrad of megaspores. × 390.

**11.** Eight-nucleate embryo sac. × 390.

**12.** Ovule with eight-nucleate embryo sac. × 86·5.

whole periplasmodium is used up by the time the pollen grains are ripe.

*Male Gametophyte.*—The divisions in the microspore mother cells are successive and the tetrads are isobilateral (Fig. 4), although occasionally they have the shape shown in Fig. 5. The microspore nucleus divides to form the tube and generative nuclei which are separated by a delicate plasma membrane (Fig. 7). The generative cell soon begins to take a deeper stain and often shows a sickle-shaped appearance in later stages. A feature of some interest is that in some pollen grains, the tube nucleus increases in size, its reticulum spreads, and finally breaks up to form small specks scattered in the pollen grain (Fig. 8).

When the anther is mature, the epidermis and the middle layer are practically disorganised and only the endothecium remains. Several attempts were made to find if the pollen grains germinated in the anther, but only a few such cases were seen and surprisingly enough the germination started not in the underground flowers but in the aerial ones. The pollen tubes were, however, very short and never reached even so far as the wall of the anther. Even if they could develop further, it is very doubtful if they could succeed in penetrating the endothecium which has the usual fibrous thickenings in all cases.

*The Ovule.*—The ovary is trilocular and contains 4 or 5 ovules, although sometimes

only 3 are present due to an early abortion of the others. Each ovule is campylotropous and has 2 integuments which are free from each other and also free from the nucellus throughout their entire length, a feature recalling the situation seen in Gymnosperms. In the older ovules they have a peculiar folded appearance and the nucellus forms a short beak-like outgrowth which comes up to the level of the micropyle (Fig. 12).

*Megasporogenesis.*—There is a single hypodermal archesporial cell, though occasionally two are present in some nucelli. The cells adjacent to the archesporial cells, however, often show similar staining reactions and simulate the sporogenous tissue in appearance.

Guignard (quoted in Schnarf[3]) mentioned that in *C. stricta* no wall cell is cut off. We have found several clear instances of the presence of a wall cell in *C. benghalensis*, but it is quite true that frequently the archesporial cell functions directly as the megaspore mother cell without cutting off any wall cell. A similar condition has been noted by Maheshwari[4] in *Ophiopogon wallichianus*, a member of the family Liliaceæ.

Another important point is the presence of a normal tetrad of megaspores (Fig 10). Guignard wrote that in *C. stricta* the development is of the Scilla-type, but this appears to be incorrect, for it is unlikely that the two species should differ so widely with regard to such an important point as this.

*Female Gametophyte.*—The chalazal megaspore functions and the further development of the gametophyte is of the conventional type found in angiosperms (Figs. 11, 12). The synergids have well-defined hooks and the antipodal cells are rather ephemeral. The two polar nuclei meet somewhere in the middle of the embryo sac or towards one side.

*Fertilisation.*—Numerous pollen grains were seen germinating on the stigma in both chasmogamous and cleistogamous flowers. Although we have seen but one case of actual fertilisation, the presence of pollen tubes in the older ovules seems to indicate that the process goes on in the normal way.

[3] Schnarf, K., *Vergleichende Embryologie der Angiospermen*, Berlin, 1931.

[4] Maheshwari, P., *Contributions to the Morphology of some Indian Liliaceae.* I. The gametophytes of *Ophiopogon wallichianus* (in the press).

*Endosperm and Embryo.*—The endosperm is of the free nuclear type met with in other members of the family that have been investigated. The embryo is very slow in its growth.

A complete bibliography will be given in the full paper which will appear elsewhere.

P. MAHESHWARI.
BAHADUR SINGH.

Agra College,
Agra.
*September 1934.*

## A Note on the Presence of Parietal Cells in the Nucellus of *Convolvulus arvensis* L.

DAHLGREN[1] (1927) says that parietal cells in the *Sympetalæ* have been proved with certainty only in the *Plumbaginaceæ* and *Cucurbitaceæ*. In the *Convolvulaceæ* the absence of parietal cells has been reported in *Cuscuta lupuliformis* and *Cuscuta epithymum* by Dahlgren (1927) and in *Cuscuta reflexa* by Johri[2] whose paper is to be shortly published.

The presence of parietal cells in the *Convolvulaceæ* was first reported by Peters (1908)

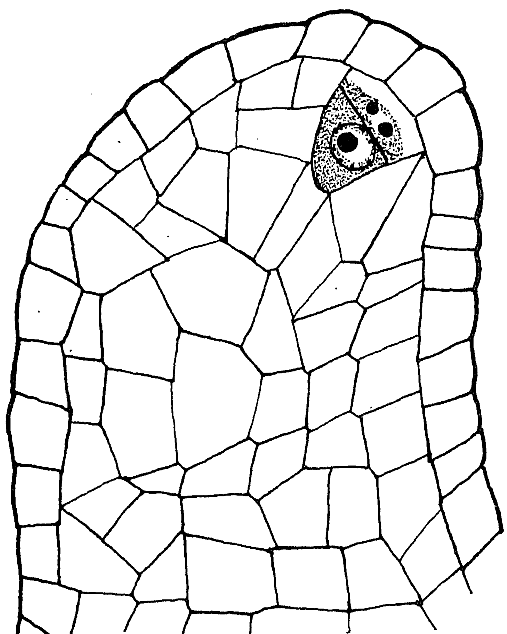


**Fig. 1.**

[1] Dahlgren, K. V. O., "Die Morphologie des Nucellus mit besonderer Beruck-sichtigung der deckzellosen Typen," *Jahrb. Wiss. Bot.*, 1927, **67**, 347.

[2] Johri, B. M., "The development of the male and female gametophytes in *Cuscuta reflexa*" (in the press).

both in *Convolvulus* and *Cuscuta*. This was regarded as doubtful by Dahlgren (1927) who

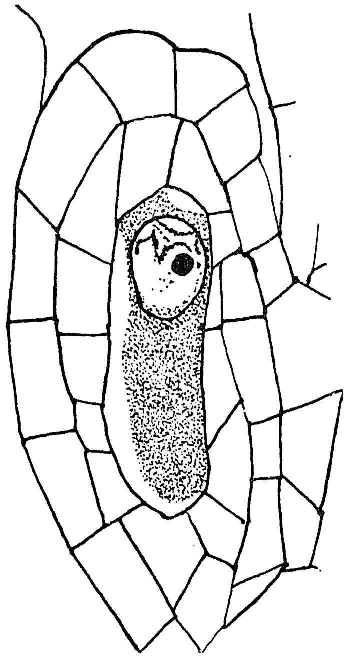


**Fig. 2.**

explains such appearances as being due to the sections not being cut parallel with the long axis of the nucellus.

During my work on *Convolvulus arvensis* I saw several median sections of the nucellus and from an examination of these I can state definitely that the primary archesporial cell cuts off a primary parietal cell (Fig. 1) which soon divides anticlinally with the result that the megaspore mother cell is separated from the epidermis by one layer of cells (Fig. 2).

I am greatly indebted to Dr. P. Maheshwari for kindly suggesting me this work.

KANHAIYA LAL MATHUR.
Government College,
Ajmer,
*September 1934.*

## The Female Pre-pupa* of *Aptinothrips rufus*.

The description of some of the young stages of *Aptinothrips rufus* has been wanting. Priesner[1] has described the larval and pupal stages of the female. The pre-pupa markedly differs from the pupa in the position of the antennæ which are extended forward (Fig. 1) and from the larva in good many characters.

Total length 1·1 mm.

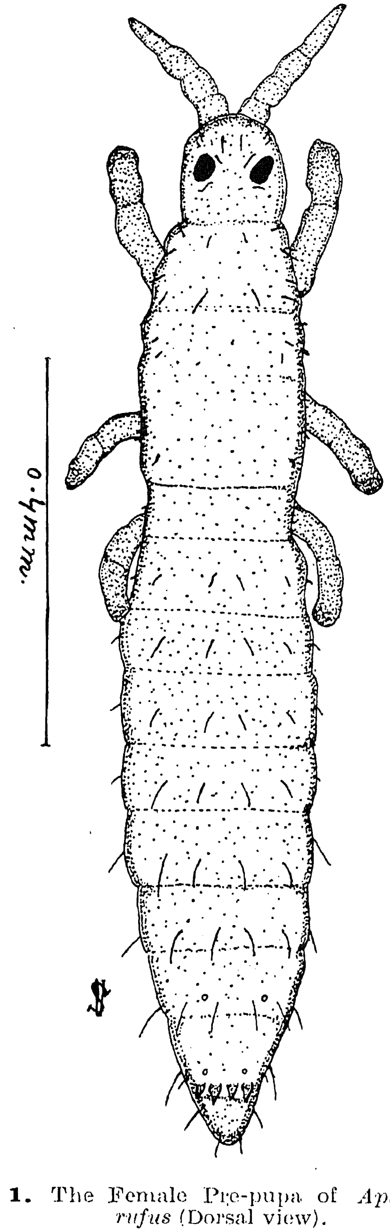



**Fig. 1.** The Female Pre-pupa of *Aptinothrips rufus* (Dorsal view).

General body colour—pale yellow ; antennæ legs and abdominal tip—light and whitish. eyes reddish black.

Antennæ—smooth with bases near, lying straight in front of the head, about one and

* The specimens were collected in King's Park, Edinburgh, in 1931-32 and were identified with the collection of Dr. C. B. Williams, Chief Entomologist, Rothamsted.

1 Priesner, H., *Die Jhysanopteren Europas*, Wien, 1928, pp. 160-161.

one-fifth times as long as the head, clothed in a thin membrane. Various segments not clearly distinguishable, a few faint constrictions dividing it into four obvious joints; first, bowl shaped, wider than long; second, third and fourth longer than the first; the last segment about 3 times as long as the first.

Head—light yellow, rounded above eyes, almost as long as broad; cheeks parallel, eyes short. Hairs on the head very minute, one hair on each side below the lateral profile of the eyes. Mouth-cone not visible. Length 120 $\mu$; width 126 $\mu$; width across eyes 113 $\mu$.

Prothorax—longer and wider than the head but wider than long. Sides sub-parallel with anterior and posterior angles rounded. Length 130 $\mu$; width 160 $\mu$; one very small hair each side behind the coxæ and two short hairs 23 $\mu$ situated at the posterior corners.

Pterothorax—longer than the head or prothorax, almost as long as the breadth of prothorax, wider than long. Length 166 $\mu$; width 186 $\mu$; Hairs very minute are situated on the sides.

Legs—not well differentiated into different parts. Length of fore, mid and hind legs almost equal.

Abdomen—pale yellow, fusiform, wider anteriorly and gradually tapering posteriorly ending in a blunt point. Segments not so clearly differentiated as in the larvæ. Length and (Breadth) of 1–7 segments are 40 (176) $\mu$; 66 (186) $\mu$; 73 (210) $\mu$; 73 (220) $\mu$; 76 (220) $\mu$; 83 (210) $\mu$; 70 (196) $\mu$. Hairs on the abdominal segments are very minute. Each segment has a short lateral hair, the length of these from 1–5th segments being 23 $\mu$; on the sixth and the succeeding segments the hairs are longer, about 43 $\mu$. Some minute hairs are also situated on the dorsum. On the ninth segment at the posterior part, a short distance from the tip, are visible four short, strong thorn-like yellowish spines (25 $\mu$ long $\times$ 8 $\mu$ wide at the base). The thorn-like spines at the posterior part of ninth segment with undifferentiated antennæ lying in front of the head differentiates it from the larval and pupal stages.

U. S. SHARGA.

Govt. Agricultural College,
Cawnpore,
*October 5, 1934.*

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## The Multiplication of Scientific Societies.

THE well-meaning letter of Dr. Gilbert J. Fowler under the above heading, appearing in the September number of *Current Science*, does not appear to take sufficient account of the geographical difficulties in India, to which he incidentally refers. The need for the multiplication of local societies in this country like the Biochemical Society, Calcutta, is both great and urgent.

The formation of such regional bodies does not mean that opinion is against the existence of a central body, which, in fact, is necessary for co-ordinating research, preventing isolation as well as overlapping, issuing publications, etc. How exactly this co-ordination can be effected is a matter of detail.

As regards Biochemistry, I think, it should develop as a full-fledged independent science in this country as elsewhere, through its own organisations. There is unfortunately still a tendency in India to make it subordinate to Chemistry, Biology or Medicine. This does not appear to be in the interest of the science, although Biochemistry must necessarily be intimately connected with chemistry and the biological sciences.

B. C. GUHA.

P. 109, Lake Road,
Calcutta,
*October 3, 1934.*

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I REGRET that Dr. Guha's letter seems to ignore the essential point that I strove to make in my letter in your September issue under the above heading. I wished to stress the importance above all things of a unity of interest in science to which geographical difficulties *should* be incidental.

In the case of Biochemistry the Society of Biological Chemists, India, having its headquarters in Bangalore where Biochemistry was first systematically taught in this country, has not sought in any way to work independently of existing organisations. Nevertheless, it has held valuable meetings, has published some useful monographs and Annual Reports and has a flourishing Branch centre in Bombay. It holds its Annual Meeting on the occasion of the Science Congress and has in fact so far represented the interests of biochemical workers throughout India. Its President is a distinguished Calcutta scientist and the

Executive Committee contains representatives from seven centres in addition to Bangalore. The contributors to the annual summary of Biochemical and Allied Research in India are equally representative.

The necessity, therefore, for a new Society is difficult to understand.

GILBERT J. FOWLER.

Bangalore,
*October 8, 1934.*

## Research Notes.

### On the Class-number of the Imaginary Quadratic Field.

RECENTLY Heilbronn (*Quarterly Journal of Mathematics*, **5**, 150) has proved an old conjecture of Gauss which remained unproved for more than a century. The knowledge about the class-number and the structure of the class-group of an algebraic field are of great importance in the theory of algebraic numbers. They certainly increase our knowledge of higher arithmetic. Unfortunately we know very little about them. Even in the case of the simplest fields such as the quadratic and cyclotomic fields very little is known. The latter field is important in connection with the great theorem of Fermat. The case of the imaginary quadratic field is very interesting as it is connected with many other branches of mathematical analysis. For instance, the equation of the singular moduli of elliptic functions is of degree equal to the class-number $h(-d)$ of the field $K(-\sqrt{d})$ where the ratio of the periods of the elliptic function belongs to $K(\sqrt{-d})$. The Galois group of the equation is isomorphic with that of the corresponding class-group. Gauss conjectured that $h(-d) \to \infty$ as $d \to \infty$. He also proved that the highest power of 2 contained in $h(-d)$ is $2^{t-1}$ where $t$ is the number of odd prime factors of $d$. Dirichlet gave a finite expression for the class-number in terms of quadratic residues which he proved by transcendental methods. This is considered by most mathematicians as one of the most beautiful results in mathematics. That was the first time when transcendental methods were employed in the theory of numbers and this has grown to be a separate branch of mathematics since thirty years. There was great development in this branch especially during the past twenty-five years. After fruitless attempts by many scholars, Heilbronn has proved the first conjecture of Gauss by transcendental methods. Now Chowla (*Proc. Indian Acad. Sci.*, 1934, **1**) by sharpening his methods slightly, proved that $\frac{h(-d)}{2^{t-1}}$ also tends to $\infty$ with $d$ which includes another hypothesis of Gauss and Euler. This means that the degree of the equation of singular moduli tends to $\infty$ with $d$. Incidentally this also shows those values of $d$ for which the equation is solvable by means of quadratic radicals only are finite in number. It is interesting to find out whether there are only 65 of them as was conjectured by Gauss and Euler. It appears that the upper bound of $d$ obtained by these methods will be far greater than 1848 the highest number that Gauss has given.

K.V.I.

### Zur Auflösbarkeit der Gleichung $x^2 - Dy^2 = -1$.

IT is known that the diophantine equation $x^2 - Dy^2 = 1$ has an infinite number of solutions for every value of D, but the equation $x^2 - Dy^2 = -1$ does not always possess a solution. A necessary condition for this is that it should be expressible as the sum of two squares but this is by no means sufficient. We have of course the continued fraction condition but this is neither a satisfactory one nor is it simple. The question of its solvability is important in connection with the class number and class field of $K(\sqrt{D})$. Epstein (*Jour. fur. Math.*, **4**, 171) treats this problem by very elementary methods and obtains the necessary and sufficient condition to be as follows. There should exist rational integers $\alpha$, $\beta$, $\gamma$, $\delta$, such that $D=\beta^2+\gamma^2$, $K\beta-\gamma\delta 1=1$, and $\alpha^2+\gamma^2$ is a square. Some other allied results are also given in the paper.

K.V.I.

### Lineare Räume mit unendlich vielen Koordinaten und Ringe unendlicher Matrizen.

KOTHE and Toeplitz have contributed a very interesting and thoroughly developed paper (*Jour. fur. Math*, 1934, **4**, 171) on linear spaces with an infinite number of

coordinates and rings of infinite matrices in them giving a unified theory of maximal matrix rings in various spaces. The difficulties that arose in the solution of this problem have been conquered by introducing another related space, which is named the dual space and which is formed out of all points. $V = (u_1, u_2, \ldots, u_n, \ldots)$ for which $\Sigma u_n x_n$ converges for all points $X = (x_1, x_2, \ldots x_n, \ldots)$ of the original space. If the dual of the dual space is identical with the original, then the space is called perfect (Voll Kommen). With these definitions they proved the following theorem; *viz.*, "If the space is perfect then all its linear transformations form a maximal ring." The three spaces for which this theorem was known are easily shown to be perfect by the authors. We have here a separate proof which is very direct and simple.

Next they introduce the idea of convergence and strong convergence without the introduction of a metric as has been done by Hausdorff and Banach. This allows them to introduce homomorphy of two spaces and this has made it possible to consider the problem of obtaining all spaces homomorphic with a given perfect space. It is also shown how the problem of solving an infinite number of equations with an infinity of unknowns can be extended to spaces other than those for which the problem has been solved. The paper is complete in itself and is a very simple and elegant theory of linear transformations in generalised Hilbertian spaces.

K.V.I.

## The Magnetic Moment of the Proton.

EVER since Estermann, Frisch and Stern (*Zs. f. Physik*, 1933, **85**, 4 and 17) found out that the magnetic moment of the proton was 2·5 nuclear magnetons instead of one nuclear magneton as was assumed before, the accurate determination of the magnetic moment of the proton has become a pressing problem which must be solved before any explanation of nuclear magnetic moments on a quantitative basis is attempted. Now I. I. Rabi, J. M. B. Kellogg and J. R. Zacharias (*Phys. Rev.*, 1934, **46**, 157) describe a new method developed by them for determining the protonic magnetic moment. Whereas Stern and his collaborators measured the protonic moment by a direct measurement of the force on a proton, a correction being made experimentally for the rotational magnetic moment of the molecule, the present authors have used a method involving the interaction between the proton and the valence electron. The experiment consists in deflecting a narrow beam of hydrogen atoms in the normal $^2S_{1/2}$ state by a weak magnetic field of sufficient inhomogeneity. Instead of assuming the two orientations $m_s = +\frac{1}{2}$ and $-\frac{1}{2}$, the atom takes up four positions corresponding to $(m_s, m_i) = (\frac{1}{2}, \frac{1}{2}), (\frac{1}{2}, -\frac{1}{2}), (-\frac{1}{2}, \frac{1}{2})$ and $(-\frac{1}{2}, -\frac{1}{2})$. The component of the magnetic moment of the atom in the direction of the field is respectively $f_1 = 1$, $f_2 = x/(1+x^2)^{\frac{1}{2}}$, $f_3 = -x/(1+x^2)^{\frac{1}{2}}$ and $f_4 = -1$. Here $x$ is given by $x = 2\mu_0 \mathrm{H}/hc\Delta\nu$ where H is the magnetic field, and $\Delta\nu$ is the hyperfine separation between the levels F=1 and F=0 in cm.$^{-1}$ Then $\Delta\nu = (32\pi/3hc)\,\mu_p\,\mu_0\psi^2(o)$ or putting in numerical values $\mu_p = \Delta\nu/0{\cdot}0169$. The deflection of a beam is given by

$$S_d = \frac{f_j\mu_0}{4kT} \times \frac{\delta H}{\delta y}(l_1{}^2 + 2l_1 l_2)$$ where $f_j$ are the functions mentioned above, $l_1$ and $l_2$ are the distances the atom moves in the field and outside the field. The atoms are produced in a long Wood discharge tube. They pass through slits and traverse the inhomogeneous magnetic field due to two wires carrying a current and the deflected beam is detected by means of a plate covered with molybdenum oxide which turns blue where the atomic hydrogen falls on it. The value obtained for the protonic magnetic moment was $3{\cdot}25 \pm 10\%$ nuclear magnetons. The discrepancy between this and Stern's value $2{\cdot}5 \pm 10\%$ is rather large, but at present the substantial agreement of the two results is more important than their difference.

## The Magnetic Moment of the Deuton.

THE magnetic moment of the deuton is a very important quantity since the deuton is the simplest composite nucleus and a study of its magnetic moment is necessary for an understanding of nuclear structure. Theoretical explanations of nuclear magnetic moments depend upon the assumed value of the magnetic moment of the neutron. There is a conflict of opinion regarding this quantity, Schüler and his collaborators considering it to be $-3{\cdot}5$ while Landé and Inglis, and Altschüler and Tamm hold it to be $-0{\cdot}6$. The

magnetic moment of the deuton must throw some light on that of the neutron since it consists of a neutron and a proton. I. I. Rabi, J. M. B. Kellogg and J. R. Zacharias (*Phys. Rev.*, 1934, **46**, 163) have determined the magnetic moment of the deuton by the method they have developed for the proton and described in a previous note in this journal. They obtain the value $0\cdot77\pm0\cdot2$. Since their experimental method does not determine the sign of the magnetic moment the value for the proton may be $\pm3\cdot25$ ($\pm$ 10%) while that of the deuton is $\pm$ $0\cdot77$ ($\pm0\cdot2$). If the magnetic moments of the proton and the neutron are supposed to add together into that of the deuton, the magnetic moment of the neutron must be about $\pm2\cdot5$ or $\pm4\cdot0$ according as the magnetic moments of the proton and neutron are directed opposite to each other or in the same sense.

### A New Method for the Determination of Transport Numbers.

THE "Balanced boundary method" developed by Hartley and co-workers (*Trans. Faraday Soc.*, 1934, **30**, 648–662) provides a long-felt want in the moving boundary technique for the determination of transport numbers. Hitherto, one had but to resort to the less accurate Hittorf method for determining the mobilities of the more slowly moving ions. For, one is confronted with a great difficulty in finding a suitable "indicator ion" in such cases. This difficulty is eliminated in the present method by having the slow moving ion in the indicator position and determining its mobility by taking advantage of the Kohlrausch relation:

$$\frac{T_R}{C_R} = \frac{T_X{}^k}{C_X{}^k}$$

where $T_R$ and $T_X{}^k$ are the transference numbers of the leading and the indicator ions at their respective concentrations $C_R$ and $C_X{}^k$, the latter referring to the concentration of the indicator ion in the Kohlrausch solution (and not in the initial solution).

Conductimetric analysis *in situ* is shown to be inapplicable for determining the composition of the Kohlrausch solution, owing to the interference by the cyclic electrolysis taking place at the A.C. electrodes. An ingenious device has been adopted for displacing samples of Kohlrausch solution into an external conductivity cell, without the interruption of the direct current. A new method of getting at a sharp boundary has also been described.

The method has been tested by measurements with electrolytes whose transference numbers are known and is shown to be capable of a high degree of accuracy.

K.S.G.D.

### The Significance of X-Bodies in Virus-Infected Plants.

THE occurrence of cell inclusions in plants caused by viruses or ultramicroscopic organisms, has been recorded in a comparatively few cases, chiefly the mosaics. Apart from their ætiological significance as the prime cause of disease, their utility for diagnostic purposes is quite limited to the few cases known so far. The simple question why these bodies are not to be traced in other cases of virus attacks, has been engaging the attention of several workers. It has been held in some quarters that these are mere artefacts probably brought about through abnormal metabolic products resulting from infection and reacting with the fixatives employed in the cytological technique. Since biochemical changes consequent on virus attack need not be the same in all species of plants examined, this reaction to coagulating agents, apparently identical in the few instances known, may be due to similar changes induced in the different host plants. Whether this is so or not, is a matter for biochemists to investigate. It will, however, readily be seen that these new aggregates or X-bodies result from virus infection and can by no means be construed as the cause of disease. The most recent contribution on this subject is due to Sheffield (*Ann. Appl. Biol.*, 1934, **21**, No. 3). Following his previous announcement on the action of molybdenum on cells, the author chooses two lines of investigation—the first on the action of coagulating agents on the cytoplasm and the formation of bodies in uninfected plants and the second on the possibility of inhibiting the formation of the same through chemicals in virus-infected plants. For want of adequate knowledge on this problem, the author has to adopt miss or hit methods, as the choice of chemicals lies within wide limits. Among those tried many are fixatives used in cytology. The reason for selecting nickel, molybdenum,

etc., are apparently due to the presence of these in such plants. One wonders if these are exclusively present in diseased cells alone. Moreover, the choice of tissues is indeed the prime factor in such studies and offers the greatest difficulty. In spite of this, the attempt made by the author is a valuable one, though cursory. The technique adopted is simple and neat. The intra-cellular changes have been followed closely. Practically everyone of the reagents employed, has been able to induce stimulation of the cytoplasmic stream similar to that which is observed as a result of virus infection. The author has detailed his observations on the action of ammonium molybdate and reproduced in a striking manner, the formation of bodies similar to those observed in aucuba mosaic. It has been argued by the author that this phenomenon is not due to a secondary effect, since analysis of treated plants showed an 'abundance' of molybdenum. It may, however, be suggested, that the application of such heavy chemicals might result in the non-availability of certain essential nutrients, particularly phosphorus in this case. This reaction to such treatments may be intense when the chemical is added to the soil. Several other coagulating reagents were tried and have responded quite similar to the above—thus lactic acid induces the formation of amoeboid bodies—resembling the X-bodies of tobacco mosaic.

The second technique of inhibiting the formation of such bodies in virus-diseased plants or of dispersing the same artificially after their formation, has not yielded any positive result. The subject is one of great interest and it is hoped ere long a further contribution on the same will be made available for the benefit of others engaged in the same field.

V. I.

### Synthetic Resin Hyrax.

IN a recent note to the *American Mineralogist* (August 1934, **19,** No. 8) E. N. Cameron of New York University has discussed the utility of synthetic resin Hyrax as a mounting medium; and it comes as a welcome relief to many petrographers and mineralogists since the use of Hyrax as a medium for mounting minerals has got a decided advantage in certain cases over Canada Balsam. Since Hyrax has a high index of refraction it will be useful for (i) increasing the relief of minerals which have indices of refraction close to that of Balsam; (ii) decreasing the relief of minerals which have indices of refraction much above that of Balsam; (iii) facilitating the identification of certain minerals. Hence the use of Hyrax as a medium for permanent mounting of grains belonging to mineral assemblages in sedimentary petrography is obvious. The photomicrographs reproduced in the paper further show that intergrowth of minerals can be better studied when mounted in Hyrax.

### Periodicity of Earthquakes.

CHARLES DAVISON, the noted seismologist, has contributed a very interesting paper on the diurnal periodicity of Earthquakes in the July-August number of the *Journal of Geology* (**42,** No. 5). By counting the number of Earthquakes occurring during each hour of the day from the recorded observations from Great Britain, Japan and Italy, he has shown by means of a curve that the maximum falls at midnight and at noon. Considering the causes of earthquakes, he has further suggested that if the earthquakes were mainly due to depression of the crust, the diurnal and annual seismic epochs would occur about midnight and midwinter. If the earthquakes were mainly due to elevation of the crust the epochs would occur about noon and midsummer. Further an important conclusion has been established that the midnight and the winter maxima prevail in regions where the earthquakes are of low intensity, and the noon and summer maxima in regions visited by much destructive shocks.

### The Idiochromosomes of an Earwig *Labidura riparia*.

J. J. ASANA and SAJIRO MAKINO (*Jour. of Morph.*, 1934, **56,** No. 2, 361-370) describe the behaviour of the chromosomes in the Indian Earwig *Labidura riparia* with special reference to the idiochromosomes. The diploid number is 14—6 pairs of autosomes and XY in the male and 6 pairs of autosomes and XX in the female. The autosomal constitution of this species differs from that of the American forms described by Morgan; the latter has two chromosomes less than the former. The X and Y chromosomes have been traced to a single chromatin nucleolus derived from the nucleolus

of the last spermatogonial division. The chromatin nucleolus retains a clavate form through the early and late periods of growth and this form is retained till the metaphase of the first spermatocyte division is reached. It is suggested that the behaviour of the chromatin nucleolus of *Labidura riparia* resembles that of the chromatin nucleolus of Oecanthus described by Makino.

### A Cytological Study on the Liver of the Rat with Special Reference to the Intracellular Blood Canaliculi, Inter- and Intra-cellular Bile Canaliculi, Mitochondria and Golgi Apparatus.

EDITH M. JAY (*Jour. of Morph.*, 1934, **56**, No. 2, 407-421) makes an interesting contribution to the cytology of the liver and interprets the so-called 'intracellular blood canaliculi' described by Schafer and his pupils as artefacts produced by the differences in the osmotic pressure and the mechanical pressure employed in administering the injection masses. She further demonstrates that a permanent system of intracellular bile canaliculi described by the earlier authors does not exist and that the short knob-like intracellular projections from the intercellular bile canaliculi possibly represent the passage of the secretion into the intracellular canaliculi. Though the presence of glycogen effectively hinders the processes of impregnation, her observations on the Golgi apparatus and mitochondria confirm those of Cramer, Ludford and others.

## Irrigation Research in the Punjab.

THE investigations that are being carried out in the Punjab have as their objects the improvement of design of irrigation works, the reduction in the costs of maintenance of channels, the control of the rise in water-table and the prevention of soil deterioration under irrigation. In order to carry out these investigations the following Sections of the Research Institute have been established—Hydraulic Section, Physics Section, Chemical Section, Land Reclamation Section, the Statistical Section and Mathematical Section. A brief account of the work of each of these sections will indicate the lines of work that are being pursued.

### 1. HYDRAULIC SECTION.

The essential features of a canal headworks in the Punjab are a weir across the river to obtain command of the land and the head regulator of the canal. One or more bays of the weir are provided with under-sluices for purposes of regulation. The weir consists usually of an upstream apron, the crest, the down-stream glacis, and below this the block protection. If the weir fails, the whole of the irrigation in the canal system may fail. It is of the greatest importance, therefore, to design a weir so that it will stand up to the strains imposed upon it. Experience has shown that weirs may fail due to the floor not being heavy enough to withstand the unbalanced head. The pressure under the floor of the weir may be greater than the pressure on the floor. If this is the case and the floor is not strong enough, the floor may be lifted with disastrous consequences. The pressures under the floor as influenced by various forms of design have been studied and, as a complement to this, methods for controlling the flow on the floor have been investigated.

The methods for investigating the flow under a work have already been described.[1] The tanks used in these experiments have been adapted to study the pressures and it is now possible to place a model of a work in the tank and determine accurately the pressure that will be experienced on any portion of the floor. Fig. 1 is an illustration of a model of Khanki Weir, Bay 4.

In order to examine the condition of flow over the weir a scale model of a section of the weir was constructed in the flume and the effects of the different conditions of flow actually experienced on the work were examined. In order to render a work safe, it is essential that the velocity of flow in contact with the floor should be as low as possible. The methods that have usually been adopted to secure this have had as their basis the destruction of energy. The subject was examined from an entirely new point of view in the Punjab Laboratory. If the high velocity water could be thrown to the surface and a low velocity water be made to travel along the floor, the problem would be solved since a high velocity water at the surface could do no damage. It has been found that by placing arrows a short distance below the crest of the weir and raised control blocks at the end of the floor, the flow along the floor is extremely slow. Determinations of the velocity of flow show that the arrows throw the high velocity water to the surface and the raised blocks check the flow of the bottom water. Under these conditions no standing wave, as usually understood, is formed. Instead a wave which has only a forward motion is produced. In order to distinguish this wave from the standing wave it has been designated "forced jump". Fig. 2 shows the design adopted for the down-stream protection of Khanki Weir.

An examination has now been made of the prototype after the weir, according to the new design, has been in operation for one flood season. It has been found that the form of flow over the weir is identical with that predicted from the model experiments and that the greatest settlement of the loose blocks has been 0·5 foot, while the majority have not settled more than

[1] *Curr. Sci.*, 1934, **2**, 367-370.

0·2 foot. This will result in a large reduction in the cost of maintenance of the weir since large scour holes down-stream had to be filled annually with stone at considerable expense.

One further important result of these investigations is worth noting. Before these studies were made, it was impossible to obtain information upon which the designs of the floor could be based. Since it is now possible to determine the pressures under the floor and also the profile of the water surface on the floor, the unbalanced head can now be evaluated and the position that this will occupy on the floor can be stated. As a result the thickness of the floor can be calculated and the area requiring reinforcement can be determined. The design of Bay 8 of Khanki Weir which is to be reconstructed during the Cold Weather of 1934-35 has been based on these laboratory experiments. Further work on the same subject is in progress with the object of adapting arrows and raised control blocks to canal falls.

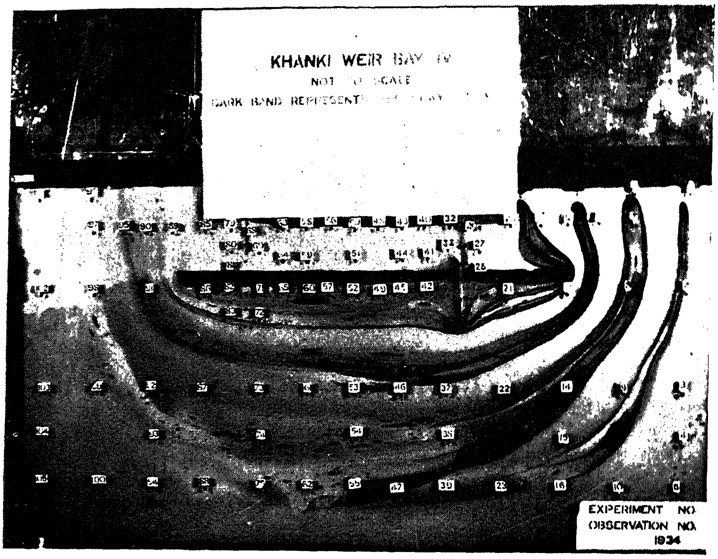


**Fig. 1.**

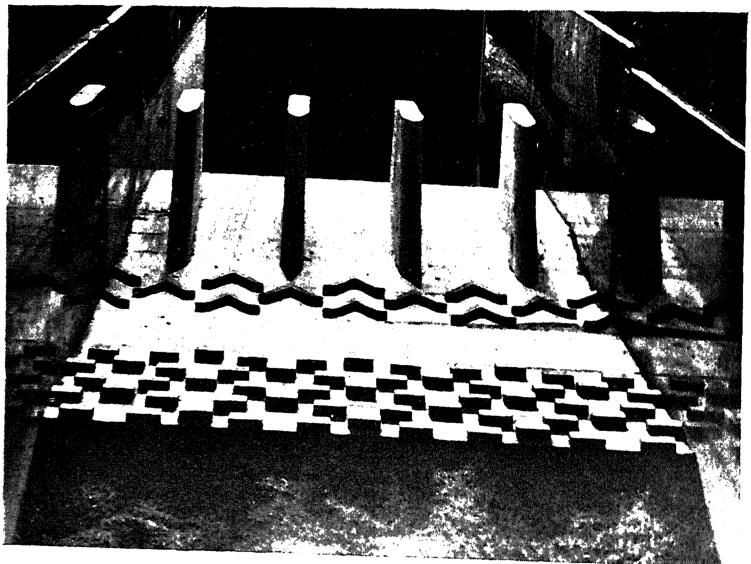

**Fig. 2.**

Another important investigation now in progress in the Hydraulic Section is the study of the silt in canals. The Physics Section has collaborated in this investigation by designing a Siltometer which can be used for deriving the distribution curve of the bed silt. If silt accumulates in the bed of a channel, the channel must become wider in order to carry the designed

supply. This widening of the channel entails a large expenditure to protect the banks. The object of the investigation is to study the relation of the silt type to the hydraulic data of the channel. Observation sites have been established on a number of channels and the hydraulic data that has been collected is being examined in conjunction with the characteristics of the bed silt at the site.

The silting of the Upper Bari Doab Canal has been thoroughly examined both at observational sites and on models. As a result a silt ejector has been designed and constructed for dealing with the silt. This ejector is now returning to the river about thirty per cent. of the silt entering the canal. Extensions of the ejector are to be made with the object of controlling the remainder of the silt. As a result of this silt control maintenance costs will be considerably reduced and the re-modelling of channels will become unnecessary.

### 2. STATISTICAL SECTION.

The research work of the Statistical Section has been mainly concerned with the investigation of the factors responsible for the rise in water-table in irrigated areas in the Punjab.

The data for the work are the records of well levels, the rainfall, the canal discharges and the areas commanded. Fortunately the level of water in the wells has been recorded from a considerable time. The first area investigated was that commanded by the Upper Chenab Canal in which water-logging is a serious problem. It has been shown that the variation in the level of the water-table is directly related to the amount of the monsoon rainfall. Fig. 3 shows the relationship between the rise in water-table between June and October and the monsoon rainfall.

It has also been demonstrated that there is no significant relation between the amount of irrigation water that the land receives and the rise in water-table. From the data it has been shown that the greater the amount of irrigation water that the land receives the less is the rise in water-table between June and October. This is due to the fact that in years of low rainfall there is a keen demand for canal water, while in years of high rainfall the demand for water is relatively small. Since it has been shown that the monsoon rainfall is the factor determining the variation in the water-table, the foregoing result as regards irrigation is to be expected. Before the investigations of the causes of the rise in water-table had been carried out, canal closures were tried as an anti-water-logging measure. These have now been discontinued as they have been shown to be of little value and interfere with agricultural operations to a harmful extent.

Since the monsoon is a characteristic of the climate of the Punjab, objections to the above conclusions have been raised on the ground that water-logging was not a serious problem before the advent of the canals. The reason for the monsoon rainfall now causing water-logging is that the canals and distributaries frequently block the natural drainage lines and the land in these drainages is now cultivated thus preventing any run-off. Government has now accepted this view and has sanctioned a programme of drainage development over a period of five years. The importance of drainages as part of any scheme or irrigation development has now been recognised and attention will be paid to this in all future projects in the Punjab.

As a result of these investigations, the Statistical Section has been called upon to examine alterations in alignment of channels and in water supplies from the point of view of water-logging. In addition to this major problem, the results obtained from the silt observation sites and the pressure observation on models of works are dealt with.

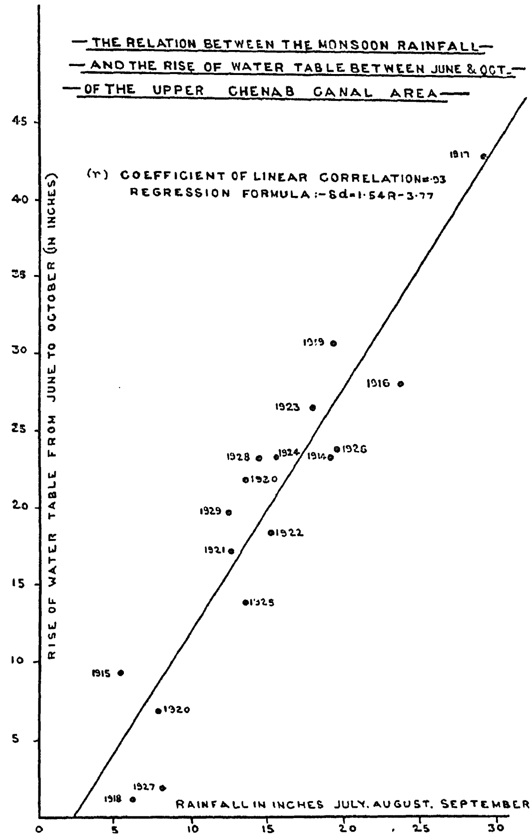


Fig. 3.

### 3. CHEMICAL AND LAND RECLAMATION SECTIONS.

The Irrigation Research Institute is unique in that it not only studies the design of works and the running of channels but also deals with the effect of the water on the land irrigated. One of the major irrigation problems in the Punjab is the deterioration of land under irrigation. As the Punjab is an agricultural province any deterioration in the soil must mean a reduction in revenue. Further, while there is sufficient water in the Punjab rivers for the present irrigation, it is doubtful whether it would be sufficient for land reclamation, a process that would have to be undertaken if land were allowed to deteriorate on a large scale. In the case of the Punjab, land deterioration may be defined as the replacement of the exchangeable calcium in the soil by sodium which results finally in the production of a soil in which alkalinity limits crop production. The soils of the Punjab plain are characterised

by an alkaline reaction and the presence of sodium salts in varying proportions. Under irrigation the tendency is for the salts present in the soil to circulate in the surface layers with the result that either the salt content or the alkalinity increases.

Extensive soil and crop surveys have been made recently and these have shown that when the pH value of the soil rises above 8·5, the crop yield tends to diminish and when the pH value rises above 9·0, rice is the only crop that can be grown successfully. When the pH value rises above 9·6 even rice cultivation is a complete failure. Large areas have already gone out of cultivation on account of the increase in the alkalinity and salt content of the soil. A much more subtle change is, however, also taking place in the irrigated areas. Since the soil usually contains small quantities of salts, base exchange reactions will take place. The rate at which these reactions take place will be slow and hence the deterioration may pass unnoticed until it has become acute. Recent work in the laboratory has been devoted to the study of these reactions. It is well known that calcium salts can react with a sodium clay to form a calcium clay. What does not appear to have been realised is that the presence of a calcium salt in the soil can *prevent* the reaction between a sodium salt and the clay. This discovery is of considerable importance as it at once points to the method for the prevention of land deterioration under irrigation. The periodical application of gypsum to the land under irrigation prevents the exchange reaction between the sodium salt and the soil and, hence, maintains the land in its original state of fertility. Since it has been shown that crop yields decline when the pH value of the land exceeds 8·5, gypsum should be periodically applied to land of this pH value to prevent further alkalinity being produced. As slow deterioration of this type may pass unnoticed it is essential to have periodical surveys of the irrigated areas so that the necessary steps can be taken to check soil deterioration before it becomes serious.

The quality of irrigation water is a subject closely allied to that of soil deterioration. Investigations carried out in the Research Institute have shown that in the case of the best Punjab soils, base exchange takes place between the clay and a sodium salt when the latter is present to the extent of 60 parts per 100,000. It has already been shown that the presence of calcium salts in the water can prevent this exchange reaction. The quality of irrigation water has to be considered, therefore, not only from the point of view of total salts but also from the standpoint of the ratio of calcium to sodium ions in solution. Standards based on this ratio are now being used for classifying Punjab waters. This investigation is of considerable importance in connection with the use of drainage waters for irrigation and also in connection with the proposed development of tube-well pumping in the Punjab. In the case of drainage waters, it frequently happens that the drains have no outfall and hence the water has to be pumped into canals and distributaries in order to dispose of it. It is essential to control the amount of water pumped from the drains if the mixed waters are not to be harmful.

A further important point in connection with the quality of irrigation water has recently been brought to light. The quality of the water is not only determined by the salts in solution, but also by the characteristics of the soil to be irrigated. It has been shown that the higher the pH value of the soil, the greater is the quantity of sodium ions in solution necessary to cause base exchange to take place. It follows from this that the higher the pH value of a soil to be irrigated, the higher can be the concentration of salts in solution without causing soil deterioration. A soil survey of the land to be irrigated is as essential as the examination of the water supply in deciding whether the water is fit for irrigation purposes in a particular area.

The complement to the laboratory investigations is the field work which is being carried out at the Chakanwali Research Farm. Rice is one of the few crops that can be grown on a soil with a high pH value. It is, therefore, the first crop to be taken during the reclamation of alkaline or salt land. It has been demonstrated, however, that rice plays a definite part in the reclamation process which consists essentially in removing the exchangeable sodium from the soil. Under the rice crop the carbon dioxide produced by the roots assists in the removal of the exchangeable sodium converting it finally into sodium bicarbonate which is removed in the drainage water. A considerable amount of information has now been acquired as to the types of Punjab soils that can be reclaimed and the types that cannot economically be brought under cultivation. The information gained has been of great value in connection with the soil surveys for project purposes. As the main factors limiting crop production on Punjab soils are alkalinity and salts a classification based on these factors has been reached which indicates their probable crop-producing power.

From the analytical results of the soil surveys, soil maps are prepared showing the soil classifications of the areas. For project purposes it is considered that if sixty per cent. of the land to be irrigated is not classified as directly culturable the project is unlikely to be financially successful.

### 4. PHYSICAL SECTION.

The Physical Section is a relatively recent addition to the Institute. The work of this section has been developed along two main lines: (*a*) the investigations of the characteristics of silt, and (*b*) the study of the seepage from canals.

The only satisfactory method of characterising a silt is by the distribution curve for particle size. The first work of the Physicist was to evolve a suitable instrument for determining the distribution curve. An ingenious Siltometer based on the principle of the optical lever was developed and is now adopted as the standard instrument in India for silt analysis. A series of observation sites on a number of canal systems were selected. The hydraulic data of the channels at these sites are taken daily and bed silt samples of the sites are also obtained. When a sufficient amount of data has accumulated it is hoped that it will be possible to determine a relation between the hydraulic data of the channel and some characteristic of the bed silt. At present from the form of the distribution curve it is possible to say whether the channel is silting or scouring, whether the channel has poor command, whether the channel has a stable bed or not and whether the channel

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Seepage losses from canals are important for a number of reasons. Any loss by seepage is water-wasted ; seepage may lead to water-logging in the neighbourhood of the canal and an allowance has to be made for seepage losses in determining the amount of water that must be supplied at the head of a channel to irrigate a given area. The study of seepage losses has been carried out both in the laboratory and in the field. The laboratory work has involved the study of the transmission coefficient of sands and soils. A relationship has been developed between the transmission coefficient and the distribution curve for particle size. It is now possible from the distribution curve to determine the probable transmission coefficient. The field-work has shown that soil type is the main controlling factor in seepage losses. The presence of salt in the soil does, however, increase considerably the seepage losses in soils that would be impermeable as determined by the distribution curve.

The Institute has also carried out investigations for Government Departments other than the Irrigation Branch. The investigation of soil temperatures in connection with the capacity of underground cables, the examination of the causes of failure of plantations, the investigation of methods of increasing the fodder supply in *barani* tracts, and the study of forest soils are instances of the work that has been carried out.

From this brief account of the research work now being done, it will be seen that attention is mainly devoted to problems of immediate practical importance. Work of a more fundamental nature is being undertaken in all sections, but until the investigations into problems of immediate practical value have been completed, this side of the Institute's activities must be curtailed.

# The Art of Chromium-Plating.*

By K. B. Parekh.

THE last decade has seen an enormous development in chromium-plated finishes applied to a variety of domestic and industrial articles. The merits of chromium as compared with nickel or silver plating have been thoroughly established, and there are at present in Great Britain more than 600 plants in operation. Perhaps the most striking characteristic of an electro-deposit of chromium is its stainless brilliancy and the ease with which the surface of chromium-plated articles can be restored to their original lustre, merely by wiping with a damp cloth. In addition, its extreme hardness and resistance to tarnish furnishes a plating that amply justifies the popularity it enjoys for numerous purposes.

Although chromium-plating was known eighty years ago the perfection in the art reached to-day is of comparatively recent origin. This is due to special difficulties of a technical nature involved in the process of chromium-plating, which could be solved only after a prolonged and intensive study of the problem.

Bloom, Piersol and others have contributed much towards the solution of the problem. In the case of chromium against other metals, the plating range is very critical, hence, current density, temperature, concentration of the bath, etc., have to be carefully controlled. Other difficulties of a special nature are connected with (1) choice of suitable anodes, (2) poor throwing power and (3) evolution of gases and porosity of the deposit.

Instead of the simple form of soluble anodes employed for every other form of electro-plating, chromium-plating calls for insoluble compound anodes whose composition also influences the success of the operation. Most suited anodes are those of lead-antimony alloy (lead : antimony : : 94 : 6).

At any given temperature the character of the deposit and also the cathode efficiency vary with the current density. On irregularly shaped articles the current density is never uniform. Consequently, in plating such articles it is difficult to obtain a bright deposit over the entire surface. The coating on the recessed part may be very thin or entirely lacking. This poor throwing power, however, is a decided handicap and has taxed the patience of those engaged in commercial chromium-plating. This has been overcome in practice by more or less empirical methods. Best results have been obtained by expedients that make the cathode current density more uniform such as, by increasing the distance between anodes and cathodes, using concentric or auxiliary anodes, or attaching a wire to the cathode which acts as a "thief" and takes away the excess current from points nearer to the anode.

In the usual chromium-plating bath, a considerable amount of hydrogen and oxygen are evolved and these carry along with them chromic acid in the form of a fine spray. These sprays can perforate the nasal septum and cause sores on the hands and feet of the workman. The chromic acid spray can be minimised to a certain extent by covering the bath with a layer of kerosene or paraffin oil. But in commerical plating, the gases are removed by adequate ventilation. As the chromium deposit occludes a large amount of the hydrogen, the plating is frequently full of pores and cracks if suitable precautions are not taken. Very thin coatings contain round pores. As the thickness is increased the porosity decreases, reaches a minimum and then increases with the thickness till large cracks are formed either in parallel or at random. Under the usual conditions of deposition there is a minimum porosity when the chromium coating is about 0·00002 inch thick. Further, due to the extreme hardness of deposit it is impossible to buff or burnish the articles so as to obtain a better finish as is the

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case with articles plated with other metals. It is essential that the articles be polished, burnished and finished to the highest order before plating, as the final lustre depends much on this preliminary operation. In the case of iron and steel preliminary plating with copper or nickel or both. is given before being chromed.

Among the several applications, the increasing use for domestic and other articles exposed to air, is well known. Its special use, for taking advantage of the wear-resisting properties, is found in the chromium-plating of fine measuring gauges and in the printing industry. The life of certain textile machinery and equipment has been surprisingly lengthened by this means particularly as regards copper printing rolls and Schr einer rolls.

## Science Notes.

*Inhibitive Power of Agar.*—Dr. B. N. Desai and his collaborators of the Wilson College, Bombay, in a communication on this subject, write: "It has been shown (Desai and Naik, *J. Bombay University*, 1933, 2, Part 2, 90) that the power of gelatine to prevent precipitation (inhibitive power) depends upon its pH besides its concentration and that the inhibitive power is different with reference to different salts which are precipitated in the gel. Thus it has been found that the inhibitive power of gelatine is minimum for gelatine of pH 5·75 with reference to precipitation of $Ag_2CrO_4$, maximum for gelatine of pH 5·00 with reference to precipitation of $PbI_2$ and continuously decreases with a decrease of pH of gelatine with reference to precipitation of AgI. In another paper (Naik, Desai and Desai, *J. Ind. Chem. Soc.*, 1934, 11, 45) it has been pointed out that the term "Inhibition" should be used to indicate power to prevent precipitation generally whether it may be due to production of super-saturated solution or of colloidal solution or of particles in a very highly dispersed condition.

"We have been doing similar work with agar and the purpose of this note is to give a summary of the results obtained so far. The following cases of precipitation in agar have been studied: (1) $PbI_2$ from solutions of $Pb(NO_3)_2$ and KI, (2) $PbCrO_4$ from solutions of $Pb(NO_3)_2$ and $K_2CrO_4$, (3) AgI from solutions of $AgNO_3$ and KI. and (4) $Ag_2CrO_4$ from solutions of $AgNO_3$ and $K_2CrO_4$. pH of agar was determined colorimetrically and samples of different pH were prepared by adding suitable amounts of acetic acid and sodium acetate. The inhibitive power was found out by determining the amount of salt ($PbI_2$ or $PbCrO_4$ or AgI or $Ag_2CrO_4$) that can be kept in the mixture for one minute without producing any precipitate, the amount of agar and the total volume of the mixture being kept the same throughout. The pH range tried in these experiments is 2·40 to 9·02, the pH of original sample of agar being 5.94. It is observed that the inhibitive power of agar with reference to different salts varies with an increase of its pH in the following manner:—

(1) $PbI_2$—The inhibitive power increases upto pH 5·94, decreases thereafter upto pH 6·78 and again increases with an increase of pH.

(2) $PbCrO_4$—The inhibitive power is minimum for pH 5·94, being greater for higher or lower values of pH.

(3) AgI—The inhibitive power increases upto pH 5·94, decreases thereafter upto pH 7·00 and again increases with an increase of pH.

(4) $Ag_2CrO_4$—The inhibitive power is minimum for pH 7·00, being greater for higher or lower values of pH.

"It would appear that the iodides of both the metals behave in one fashion and the chromates in another fashion. The condition of these substances with special reference to the nature of their Liesegang rings in agar is being investigated. Details will be published elsewhere in due course.

* * *

*A Purely Vegetable Medium for the Cultivation of Micro-Organisms (Dal Medium).*—Mr. A. C. Roy, of the School of Tropical Medicine, Calcutta, in the course of a paper read before the Bio-chemical Society, Calcutta, described the method of preparation of the *Dal* broth previously reported by Acton, Pasricha, Roy and Das Gupta (*Ind. Med. Gaz.*, 1932, **67**, 463). "According to the older technique, 500 grams of powdered *Mung-dal* (*Phaseolus mungo*) and 5 grams of papain, mixed with 5000 c c. of water, were digested at 60°–65° C. for four hours. The digestion of the *dal* for four hours at that temperature had the effect of splitting the *dal* proteins largely into amino acids. But since this *dal* broth was sought to be used as a substitute for the much more expensive peptone water, the time of digestion was reduced to one hour, when maximum peptone and very little amino acid formation took place. Various liquid and solid media such as *dal*-agar slopes, 0·5% bile-salt *dal*-agar plates (made on the same lines as MacConkey's bile-salt neutral-red lactose-agar plates) were prepared from this *dal* broth, which when diluted to contain 0·5% oxidisable matter was used as a substitute for 1% peptone solution.

"Some of the common intestinal organisms which one has to deal with in a bacteriological laboratory in India, *viz.*, Cholera and cholera-like vibrios, *Bact. typhosum*, *Bact. paratyphosum* A and B, *Bact. shigæ* (shiga), *Bact. flexneri* and *Bact. coli* were planted on the media prepared from this *dal* broth (by the modified method), using others in which peptone was employed as controls. With the *dal* media, the growth of these organisms was quite satisfactory and in most cases quicker and more vigorous than in the controls. Previously in the isolation of non-lactose fermenting organisms, there used to be many cases of failures with the *dal* the plates compared to the original MacConkey's plates. As a result of this modification the cases of failures have been considerably reduced. But even now it cannot be said that it gives as consistent results as the original MacConkey's plates.

"Attempts are being made to improve it still further so that it might be used as an efficient substitute for peptone water and in view of its extremely low cost of production (¼ to ½ anna per litre as against 6 to 10 annas per litre of

1% peptone solution) its economic significance is obvious."

* * *

*The Institute of Chemistry.*—A Joint Meeting of Members of the Indian Chemical Society (Bombay Section) and of the Institute of Chemistry was held on Wednesday, 5th September 1934 at 6-0 P.M. in the Chemistry Lecture Room of the Royal Institute of Science, Bombay, when Dr. R. C. Shah presided. There was an excellent attendance of members of both the Chemical Society and the Institute.

Dr. A. M. Patel read a paper on "Absorption of Dyes by Cellulose". The lecturer described how conclusions derived from results obtained in the last century were often erroneous due to impurities in the dyes and he explained present methods adopted to ensure purity.

The action of electrolytes in connection with absorption was mentioned and pointed out that the quantity of dye absorbed was directly proportional to the coagulating power of the electrolyte.

Absorption was rather a case of diffusion and varied with the thickness of the material and the salts used.

Methods for dyeing union fabrics, *viz.*, viscose and cotton, were described and it was pointed out that these have different affinities for dyes and that it was essential that they should be brought to the same degree which could be done by increasing the affinity or decreasing that of cotton or viscose. In attempting the former by mercerising, viscose is affected and therefore the affinity of viscose was decreased by steaming. The need for trained chemists to be in charge of dyehouse was particularly stressed.

A discussion took place mainly on practical points arising out of the lecture. The meeting concluded with the President thanking the lecturer for his most interesting lecture.

* * *

*Association of Economic Biologists, Coimbatore.*—A meeting of the Association was held on Thursday, the 23rd August, when the following papers were taken up for discussion.—(1) "*Soil Inoculation and Fungus Diseases,*" by P. D. Karunakar, dealing with the possibility of inoculating soils with saprophytic fungus, *Aspergillus* Sp., which may prevent or at least limit to a great extent the growth and activity of the parasite, *Fusarium moniliforme*. There are indications from the work done so far that this is possible. (2) "*Some Acarina of Economic Importance,*" by M. C. Cherian, deals with the *acarina* (mites and ticks) belonging to a group of lower animals of economic importance to the agriculturist. Some of these are parasitic on domestic animals sometimes acting as vectors of diseases. Some others by themselves cause skin diseases known as *Acariases*. Lastly, some are pests of cultivated plants. The part played by mites and ticks as pests of domestic animals has been studied to some extent in India but their relation to plants has not received adequate attention. The paper gives an account of the work done by the author on some South Indian Acarina with special reference to those forms found in Ganja, Sorghum, Sugarcane, Cotton, Castor, Rose, Figs, Grape-vine, Tomato, Brinjal, etc.

At a meeting of the Association held on the 26th September Mr. Abraham gave an interesting paper on the "*Preliminary Studies in the Anatomy of the Gynœcium of Cotton with special reference to Boll Dehiscence*". It has been observed in the indigenous cottons of Madras that the bursting of the bolls is rather bad in karunganni (*G. indicum*) as compared to uppam (*G. herbaceum*) and roseum (*G. N. roseum*).

An examination of the gynœcium in these varieties reveals certain anatomical features which appear to have a bearing on boll opening. Each carpel has three vascular bundles, a median and two lateral (placental). The folding of the carpels brings the margins along with the two placenta bundles close together and the margins get separated again during the dehiscence of the boll. In all cottons, the placental bundles of each carpel first arise separately from the receptacular stele, fuse together immediately and branch out again when they run through the placenta. It is observed that in dehiscence the cleavage of the carpel stops just above the region of fusion, the amount of dehiscence thus depending on the level at which this fusion takes place. In varieties belonging to species *G. indicum*, this region of fusion is situated at a much higher level than in other varieties with the result that the bursting of the boll is poor.

The inheritance of this anatomical feature has been under study in the progenies of crosses between *G. indicum* and *G.N. roseum* and between *G. indicum* and *G. sanguenium*, and there are indications that the character, bad opening, is a simple recessive.

* * *

*Society of Biological Chemists, India.*—During the month of September 1934 three meetings were held under the auspices of the Society when the following papers were presented:—(1) "The Control of Plant Diseases with special reference to Sandal Spike" by Mr. A. V. Varadaraja Iyengar, M.Sc., A.I.C., A.I.I.Sc., (2) "The Production of Mucus during the degradation of plant material" by Dr. J. G. Shrikhande, M.Sc., Ph.D., A.I.C., (3) "Influence of æration on the diastatic activity of the barley during germination" by Mr. R. H. Ramachandra Rao, M.Sc.

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*Progress of Anthropology in European Universities.*—Under the auspices of the South Indian Science Association, Rao Bahadur L. K. Anantha-krishna Ayyar delivered an interesting address on the "Progress of Anthropology in European Countries". The lecturer in his recent tour in Europe had the opportunity of visiting more than twenty famous Universities and of lecturing in a dozen of them. He gave an interesting account of the departments of Anthropology, the laboratories and equipments in these Universities as also of the teaching staff and facilities given to students for the study of the subject. The museums attached to the Universities contain a very large collection of specimens from all parts of the world and photographs to illustrate the racial types and cultural traits. In the Universities of Naples, Rome, Paris, Vienna, Berlin and others there are separate departments and museums to facilitate the study of Physical Anthropology, Ethnology and Ethnography. The museums in England are equally grand. The papers and books published by the professors of these Universities are abundant. The study of Indian Ethnology in these Universities leaves much to be desired.

Mr. Ayyar gave in contrast the study of the subject in India and emphasised the necessity for much more encouragement and the introduction of the subject in the under-graduate and post-graduate studies of Indian Universities. At present it is only the Calcutta University that has a fully developed department of these subjects.

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*Royal Institute of Science.*—Principal Dr. T. S. Wheeler has been elected as Dean of the Faculty of Science and a member of the Syndicate of the Bombay University.

Dr. Ludwig Wulf, Prof. of Textile Chemistry in the Andhra University, visited this Institute on 19th September, 1934, and saw the equipment and work in the Chemistry Department.

Mr. G. V. Jadhav, M.Sc., of the Chemistry Department has been awarded the Sir Mangaldas Nathubhoy Foreign Scholarship.

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Dr. G. C. Chakravarti, D.Sc., Lecturer in the Department of Organic Chemistry, Indian Institute of Science, Bangalore, has resigned his appointment for reasons of ill-health. The staff and students of the department met under the presidentship of Dr. P. C. Guha, D.Sc., on Saturday, the 15th September 1934, and passed a number of resolutions placing on record their appreciation of the valuable services rendered by him.

Dr. Chakravarti's contributions relate chiefly to the chemistry of the dye-stuffs. Just prior to his retirement he had begun an investigation on the natural colouring matters of "Alkanet" and suggested a tentative constitution for "Alkanin". It is rather unfortunate that he could not complete this interesting enquiry.

* * *

*University of Lucknow.*—Dr. S. N. Das Gupta has been appointed to the post of Reader in Botany at Lucknow University, vacated by the death of Dr. S. K. Mukerji, F.L.S. Dr. Das Gupta is a Ph.D. of London University, with special qualifications in mycology, a field of research to which he has made important contributions, published in the *Annals of Botany* and in the *Philosophical Transactions of the Royal Society*. Special mention may be made of his discovery of a remarkable relationship between the two strains of *Diaporthe perniciosa* $DH_C$ and $DH_F$, in which the slow-growing strain $DH_C$ cultivated in contact with the fast growing $DH_F$ dominates the latter, and is able to convert it into its own type.

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*Indian Coriander.*—According to a press communique issued by the Secretary, Imperial Council of Agricultural Research, Simla, published in a recent issue of the *Indian Trade Journal*, a detailed examination of the samples of Russian, Moroccan, Tuticorin and Rangoon corianders, as also a typical trade sample from the Udumalpet (Coimbatore District) market, revealed that the Indian Produce which is of intrinsically good quality, is losing ground mainly by reason of adulteration of the clumsiest character. The Tuticorin sample contained, 0·3 per cent. stalk, 0·3 per cent. extraneous seeds and other grains, and 20·0 per cent. dirt. The Moroccan produce contained about 0·3 per cent. stalk, about 0·3 per cent. extraneous seeds and other grains, and less than 1 per cent. dirt. The essential oil content which may be said to determine the pungency and efficacy of coriander, was about the same in both Indian and Moroccan samples, and perhaps the former showed a rather higher trend. These data clearly indicate that with "even reasonable attention to cleanliness Indian coriander can easily hold its own and it is important that steps to this end should be taken, for India cannot afford to lose any of its markets for these minor agricultural products which in the aggregate mean so much to the cultivator and market gardener."

* * *

*Lorentz Collected Papers.*—Martinus Nijhoff, publisher of "Lorentz Collected Papers" writes: "I have resolved to go on with the publication and the 8th volume (the 2nd of the set of 9 volumes) is already in the press. Vol. VII, the 1st of the set, appeared a few months ago.

"I beg to draw once more your attention to the fact that immediately after the publication of this volume—about November 1934—the work will be no longer available at subscription price.

"Subscribers to the 9 volumes may have the set for 75 *guilders*, or bound for 90 *guilders* (payment after the publication of each volume, Gld. 8.35 or Gld. 10). Afterwards the price will be 90 guilders, or bound 108 guilders."

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*The Prague International Samples Fair*, 1935.—The Spring session of the above fair will be held at Prague from 3rd to the 10th March 1935. Firms wishing to participate in this fair may obtain full particulars from the Consul for Czechoslovakia, 34, Park Street, Calcutta.

* * *

*Increased World Activity in Chemical Research.*—The Editor of *Chemical Abstracts*, Prof. E. T. Crane of the Ohio State University, draws attention to the increased output of chemical papers in 1934. Digests of papers appearing in 2,000 scientific and technical journals number 18,664 in the first six months of 1934 as against 17,648 in a corresponding period of 1933. "This increase is heartening from an economic standpoint because of chemistry's basic association with practically all of the industries. It indicates that thousands of chemists throughout the world are turning out a steady stream of new information vital to industrial and social progress."

* * *

"*Element* 91."—For the first time, a powerful radio-active substance similar to radium and, it is said, equally useful in the treatment of cancer, has been isolated. Dr. Aristid von Grosse of Chicago University, who has isolated this element, called protactinium, says that while a gram of radium costs £20,000 to £25,000, a similar quantity of protactinium will cost only £600. The American Chemical Society meeting at Cleveland has been shown the element, plainly visible under a magnifying glass as tiny silvery beads. It is the rarest metal in nature, for out of 10,000,000 parts of pitch-blende only one part of protactinium can be extracted. Even more important than the isolation of this element is the fact that Element 91 naturally disintegrates into actinium, which is 140 times more active than radium. Until her death the late Mme. Curie worked unsuccessfully on the isolation of

actinium, which Dr. von Grosse says will in a year or two be available to science and medicine.

(*Chemical Age.*)

* * *

According to a report in *Hindu* the Allahabad University Teachers have been allowed to seek elections to the Legislative Assembly and other Councils under certain conditions. Thus a teacher seeking election should obtain permission from the Executive Council, after satisfying them that his absence in connection with his electioneering work or work connected with the legislatures would not interfere with his University duties.

* * *

*The Hilger Vitameter A.*—Adam Hilger, Ltd., 98, King's Road, Camden Road, London, N.W. 1, England. (Hilger Publication No. 151/5. Post free on request.) This booklet (the fifth edition) describes the latest model of the Hilger Vitameter A for determining the Vitamin A content of cod and other fish liver oils and concentrates.

This model is of all-metal construction and embodies optical and mechanical improvements.

It may be remembered that the instrument is based on the now accepted spectrophotometric method of test. Measurements are made visually by comparing the intensity of two fluorescent areas and rendering them equal by a photometric device whose scale gives readings that are a direct measure of the Vitamin A content.

The makers claim that the instrument, which is extremely simple to use, gives accurate results even in the hands of unskilled operators.

* * *

*Indian Research Fund Association.*—Applications are invited from experts on Nutrition to undertake independent charge of Nutritional Research under the Indian Research Fund Association at Coonoor, a hill station (6,000 ft. above sea-level) in the Madras Presidency of India. Pay in the scale of Rs. 1,250–100–1,750 with usual departmental travelling and halting allowances. In addition, an overseas pay of Rs. 500 per mensem will be given to a person of non-Asiatic domicile if appointed. The commencing pay of the selected candidate may be fixed at a higher rate than the minimum of the scale of Rs. 1,250–100–1,750 if the experience and qualifications of the candidate selected justify this. All applications must be made on the prescribed form copies of which can be had from the *Secretary, Indian Research Fund Association, Civil Secretariat, Simla* (upto 19th October and thereafter, New Delhi). Final date for receipt of completed forms of application is 30th November 1934.

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*Novel pH Meter, "Pehavi".*—Announcing new type Hartmann and Braun Instruments placed in the market their Agents for India, Messrs. Adair, Dutt & Co., Ltd., have drawn our attention to several instruments in which compactness, accuracy and simplicity in manipulation have been combined in a very efficient manner. Of these great interest is being received for the new pH measuring potentiometer "*Pehavi*" which is most suitable for the Sugar Laboratories, the Clinical and Pathological Laboratories and the Chemists. This has both a pH scale—in two ranges—and a Millivoltmeter scale. Thus either a Platinum Hydrogen or a Quinhydron Electrode or any other type of Electrode can be used and for each the scale is brought into view by a rotating switch avoiding any possibility of confusion. No Standard Cell is necessary at all as the instrument is calibrated for any dry battery as is used for pocket lamps. Equally important are the two types of Universal Voltmeters "*Multavi-I*" and "*Multavi-II*" having multiple ranges in volts, amperes and milliamperes for both D.C. and A. C. and are also available for measuring resistance with the help of any dry battery or the L.T. and H.T. batteries as are used in Radio work. The "*Pontavi*" is a compact resistance bridge capable of measuring from 0·05 to 50,000 ohms and contains an enclosed dry cell and a built-in sensitive pointer Galvanometer. We are sure these new instruments would arouse keen interest amongst the general Scientists, Radio Amateurs and Technical people.

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We acknowledge with thanks the receipt of the following:—

"The Journal of Agricultural Research," Vol. 48, Nos. 11 and 12; Vol. 49, Nos. 1, 2 and 3.

"List of Publications on Indian Entomology," 1931, 1932. Miscellaneous Bulletin, Nos. 2 and 3. (Imperial Council of Agricultural Research).

"Journal of the Indian Botanical Society," Vol. 13, No. 1.

"Chemical Age," Vol. 31, Nos. 791-794.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 67, No. 9.

"Journal of the Indian Chemical Society," Vol. XI, Nos. 7 and 8.

"Experimental Station Record," Vol. 71, No. 2, August 1934.

"Educational India," Vol. I, No. 3.

"Forschungen und Fortschritte," Jahrgang 10, Nos. 25 and 27.

"Indian Forest Records," Vol. 20, No. 10.

"Monthly Statistics of the Production of Certain Selected Industries of India," July 1934, Government of India Publication No. 4 of 1934-35.

"Forest Bulletin" No. 86 (1934) Sylvicultural Series—Cold Weather Planting in Northern India.

"Agricultural Statistics of India" (1931-32), Vol. I.

"Administrative Report" (1108 M.E.), Archæological Department, Government of Travancore.

"Mathematics Student," Vol. II, No. 2.

"Medico-Surgical Suggestions," Vol. 3, No. 9.

"Memoirs of the Indian Meteorological Department," No. M/2 Meteorological conditions affecting aviation over the North-West Frontier.

"Journal of the Indian Mathematical Society," Vol. I, No. 2.

"Nagpur Agricultural College Magazine," Vol. 9, No. 1.

"Nature," Vol. 134, Nos. 3382-3385.

"Natural History," September 1934.

"Journal of Chemical Physics," Vol. 2, Nos. 8 and 9.

"Review of the Scientific Instruments," Vol. 5, No. 8.

"The Indian Trade Journal," Vol. CXIV, Nos. 1473—1476.

## Reviews.

Tirupparuttikunram and its Temples. By T. N. Ramachandran, M.A. (*Madras Museum Bulletin*, Volume I, Part iii.) Editor: Dr. F. H. Gravely.

The project of issuing, at least of resuming the issue of, the Museum Bulletins was revived a short time since through the exertions of Dr. Gravely, and is being actively carried into effect. This Bulletin constitutes the third of the series in this particular Department. Kanchi, the modern town of Conjeevaram, had achieved a great name as a *ghatika* or a Brahman settlement before the Christian era. It had a similar reputation as a centre alike of the Buddhists and of the Jains as well. While the town Conjeevaram, as it is at present, probably constituted the Brahmanical centre as the number and the location of its varying temples would suggest, the Buddhist centre seems to have been just outside the limits of the now existing town and occupied a quarter distinctly its own. So probably it was with the Jain quarter, and the village Tirupparuttikuṉṟam about a couple of miles off, on a side just opposite the Buddhist centre, gave it the reputation of a Jaina centre and possibly stands for the Jina Kanchi of literary fame. The name Tiruppa-ruttikuṉṟam is apparently given to it after a hillock or a rise of ground distinguished from the surrounding part by cotton cultivation, the kind of cotton which goes by the Tamil name *Parutti*. This would be nothing strange as in the same district and perhaps not very far off we have the village Parutti-paṭṭu, probably from the same feature. Mr. Ramachandran attempts here to equate the name with another in the same locality called Śemporkuṉṟu, translated into Sanskrit Aruṇagiri (red hill). The equation is hardly tenable and is quite unnecessary, as the latter would be the name of a particular hill in the same locality without any notion of an identification.

Its present importance, and perhaps its importance for the last 1200 years or more, is due to its having been an important Jain settlement with two of the Jain *bastis*, one dedicated to Chandraprabha, the 8th of the 24 Tirthankaras and another, and a larger one similarly dedicated to Trilōkyanātha Vardhamāna, the 24th among them. The first temple probably goes back to Pallava times from its architecture, and is assigned to the reign of Paramēśvaravarman II, the Pallava king. It is possible that it began with the reign of his predecessor, Narasimha Varman II, Rājasimha, the builder of the Kailāsanātha Temple at Conjeevaram. The Vardhamāna temple is more closely datable from the inscriptions of which a large number have been made available in this Bulletin. A number of these have already been edited by the epigraphists, and a number more have been newly brought to light. References are given to the former and the latter are published with transliteration and translation by the editor. From these we are enabled to make the inference that the temple probably began at the end of the Pallava age and received support from the Chōḷa rulers from the days of Rājēndra, the Gangaikondachōḷa, in the first half of the eleventh century, right down to Kulōttuṅga Chōḷa III and Rāja Rāja III ruling the Chōḷa empire at the commencement of the fourteenth century. This is a double shrine dedicated to Vardhamāna, the 24th Tirthankara. A number of subsidiary shrines there are in it such as the temples to Pushpadanta, Dharmadevi, Padmaprabhā, Vasupūjya and Pārśvanātha. This shrine constitutes the earliest part of the building to which a front hall or verandah was added in Chōḷa times and a larger hall still under the first dynasty of Vijayanagar. This was dedicated by the Vijayanagar general Irugappa, while his father also seems to have been devoted to the shrine, as both of them came to be disciples of the Jain saint Pushpasēna, who was a permanent resident of the locality. Further additions were made to these structures by Pushpasēna himself who is responsible for the *gōpura* in front. Even the great king Krishnadēvarāya of Vijayanagar made a grant of land. So we might say the place has been an active centre of the Jains from the eighth to the sixteenth century.

Among the Jain saints associated with the place the most important are Akalanka about the eighth century of whom there is but little of a memorial in the locality, and of the more recent ones, Chandrakīrti, the contemporary of Kulōttuṅga III, and his disciple Ananta Vīrya Vāmana belonging to the twelfth and thirteenth centuries. And later still belonging to the end of the fourteenth and the early part of the fifteenth century are the two Mallisēna Vāmana and

Pushpasēna, his disciple; the former was the preceptor of Bichappa and is the author of a number of Sanskrit works such as *Panchāstikāya*, *Pravachanasāra*, *Samayasāra*, and *Syādvāda-manjari*. He was also the author of the Tamil *Mērumandarapurāṇam* published recently by Principal A. Chakravarti of the Kumbakonam College with a commentary written by his father. This Mallisēna is also believed to be the author of the Tamil commentary *Samaya Divākara* on the Tamil work called *Nīlakēśi Tiruṭṭu*. This Bichappa was the general of the Vijayanagar emperor Harihara and his son Bukka II. His son Irugappa's name is connected with the *Mērumandara Purāṇa* and there is a statue of his in the Jain temple itself, so that the name Jinakānchi would have been well bestowed on the place and equally well deserved by it.

Coming to the temples themselves, the complex character of its structure tells its own tale in regard to the age of the several parts going to constitute the temple. Apart from the temples and images, the feature that is most prominently noticeable is the series of paintings of scenes from the lives of the saints. These are a most important feature of Jaina shrines, as in fact of Indian shrines generally. While one way of popularising religion was that of reading or rendering to musical accompaniments the stories of saints to the people who gather together on occasions of pilgrimage, this method could be reinforced by ocular demonstrations by pictures. These paintings were intended to serve the latter purpose There are 22 Plates of these representations relating to the life of the first Tīrthankara Rishabhadēva, the 22nd Nēmināṭha and the 24th Mahāvīra. Each one of these carries a label. Along with these are found a number of paintings representing the playful activities of Krishna whom the Jains regard as a cousin of their Tīrthankara Nēmināṭha. There are the lineal descendants of paintings leading back to the caves of Ajanta in India, and Śrīgiriya in Ceylon as also those of Sittannavāsal and places like that. Mr. Ramachandran, the Archæological Assistant at the Museum, has been at pains to explain these pictures from Manuscript works containing material for it, and has brought together, in addition to this, a volume of information of a more recondite kind in regard to Jainism in general. Both he and the editor, Dr. Gravely, deserve congratulation for the illuminating volume of 235 pages of the monograph itself and 24 pages of index together with 36 plates of illustrations. The Government Press which is responsible for its printing, it need hardly be added, has done its work with its usual excellence.

S. K. AIYANGAR.

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THREE ESSAYS ON SEX AND MARRIAGE. By Edward Westermarck. (Macmillan & Co., Ltd., St. Martin's St., London. (Pp. ix+335. 1934.) Price 12*s*. 6*d*. net.

These essays enitled "The Oedipus Complex, Recent Theories of Exogamy" and "The Mothers: a Rejoinder to Dr. R. Briffault" are intended to supplement Dr. Westermarck's "The History of Human Marriage". They are a thorough, closely reasoned and critical exposition of some of the obscure aspects of human mind and should be esteemed as a valuable contribution to social science.

The first part of the book is devoted to a criticism of the Freudian doctrine of the Oedipus complex and its technique, psychoanalysis, and the author concludes that the theory of unconscious makes assumptions not warranted by the facts of direct observation, accumulated by anthropological studies. It seems to us that the divergence of views between the anthropologists and the Freudian psychologists is due to the fact that they are dealing with two classes or aspects of mind from entirely different standpoints; and their methods of investigation of even common problems are bound to differ. The Freudian technique is the outcome of the development of medicine and explains the causes of hysteria and other forms of mental obssession including dream phenomena. It assumes the existence of an unconscious part of mind, the repository of repressed wishes which when the mental censor relaxes vigilance, express themselves symbolically. The business of the psychoanalyst is to explore the sewers of the human mind, slips of the tongue and pen, casual statements of children and refer them to experiences of childhood; and in pathological cases he devises suitable formulas for the removal of apprehensions and obssessions which are believed to be at the basis of the hysterical and allied maladies. The business of the anthropologist is not with the unconscious mind and unconscious statements: his province is the normal conscious mind of adult persons, in its relation to the social,

cultural and economic evolution of the peoples, and to discover law and order in the progress of human civilisation. The common ground of anthropologists and Freudian psychologists is sex which like the human mind has apparently two aspects, the official and the unofficial. The anthropologists study both the aspects in their relation with the family and communal organisation, religious and mystical practices without attempting to investigate and interpret the origin of the unofficial aspects of sex life and its bearing on the pathological and seemingly unaccountable manifestations of mind. This is the province of Freud's school.

We have read this book with that close attention which its importance deserves. It is written in self-defence. It refutes the cherished theories of Freudianism. It ridicules Dr. Briffault's criticisms of the author's views on exogamy and the relations between the sexes in primitive humanity and the early forms of marriage as expounded in his standard work, "The History of Human Marriage". It is true that the theories of Freud make great claims and the rôle which they play in the psychology of the individual is the proper field of investigation by the neurologists; but the social facts underlying the supposition of their universality and the influence they are alleged to have exercised on the history of civilisation must be the principal concern of sociologists. We are not, however, prepared to agree with Dr. Westermarck that the sociological presuppositions of Freudian doctrines are utterly unfounded, for if the human body is a derivative of some simian ancestor, the human mind cannot be an innovation. The psychologists and neurologists and sociologists who find the human mind as an abstract concept in its ultimate analysis, have not investigated the animal mind with any measure of comprehensiveness. If the human mind suffers from "Complexes", they must be part of the animal heritage with which man arrives in the world. The validity of Freudianism requires support or meets with refutation from investigations of the simian mind.

It is idle to claim that any one theory offers adequate explanation to the various types of prohibitions and alliances introduced by society in the sex relations of its members. For the perpetuation of species, Nature has provided the animals including man, with the means of securing the union of two micro-organisms of different kinds and society has elaborated round this simple process a most complex body of rituals, superstitious faiths and sanctions. Their number and mode of application depend upon the cultural strata of society: they must have evolved independently. The object of organising social groups must be the same throughout the world, and the different forms of societies must have attained their common purpose through different routes. Marriage as it is understood in civilised societies, may be discussed from the standpoint of law, religion, social and economic science or biology; its various forms, the superstitions and rituals that have developed round this institution and the conditions and sanctions prescribed by social legislators must be the outcome of various considerations in the interests of the purity and efficiency of the members entering into matrimonial relations. The accounts of these considerations, when we examine a large number of groups, must differ and might even appear conflicting: and the divergence of views between Dr. Briffault and Dr. Westermarck must be largely a matter of opinion. Even if Dr. Briffault had carefully verified his references before criticising Dr. Westermarck, there is bound to be difference of opinion about usages and their origin, because the interpretation of anthropological facts must in a large measure depend upon personal factors rather than upon abstract rules such as those derived from experimental sciences.

Everyone interested in social science will welcome this scholarly and informative book.

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PROPERTIES DES ESPACES ABSTRAITS LES PLUS GENERAUX. By Prof. Appert. (Hermann et cie, Paris, 2 Vols.) Price 24 Francs.

A proper understanding of the axiomatic development of the theory of open and closed sets, continua and domains, and some important characteristics of the subject, such as compactness, Borel-Lesbesgue property (Heine Borel), separability of various degrees and the corresponding Lindelöfian property, etc., is a *sine qua non*, for the study of analysis, especially of the theory of functions of a real variable and the theory of analytic functions. The usual development of this subject given in older text-books such as Hobson, is too highly restricted as the proofs apply only to Euclidian space and also they do not clearly indicate

how the various axioms of Euclidian space are involved in the proofs of various theorems. As a matter of fact in many of the theorems about neighbourhoods as developed in Hobson, the particular structure of Euclidian space plays no part.

Coming now to the two volumes of Prof. Appert on "Properties of Abstract spaces of a very general kind" as the title itself indicates, he develops the theory of open and closed sets, continua, etc., in such a manner as to be valid in the most general of spaces which he calls topological and naturally, it is completely free from the various defects, mentioned in the first paragraph, which characterised the older books. The subject is developed in a very logical and extremely interesting manner.

*Vol. I*—The first few chapters deal with the properties displayed by sets of points of topological space, with regard to the operation of derivation under the 1st, 2nd and 3rd axioms or conditions of F. Riesz. The sixth chapter deals with generalisation of continua and domains in generalised *space.*

The topics of discussion of Vol. II are very important and among them the most interesting theorem is that of Chittenden which proves that the necessary and sufficient condition that a set of points should have the Borel-Lesbesgue property is that the set should be perfectly compact in itself. Some of the other interesting topics deal with generalisation of (1) Cantor's Theorem on a monotone sequence of closed sets, (2) Cantor-Bendixon's Theorem, (3) Separability of various degrees....etc.

Although at a number of places examples are given showing the independence of the various axiomatic assumptions and exemplifying the various abstractly defined elements, as for example, on page 19, Vol. I, and on page 64, Vol. II, I think that there are not enough examples in the book illustrative of the various definitions. I conclude that it is an excellent book embodying some of the latest work on the subject and every student of analysis would benefit largely by a good study of the book.

K. S. K.

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LE CALCUL SYMBOLIQUE. By Pierre Humbert. (Hermann et cie, Paris, Pp. 31.) 10 Francs.

An outline of the methods of Heaviside's operational calculus is presented. The author has given references to Carson and Paul Levy for rigorous treatments of the subject. Some applications of the operational calculus have been dealt with; for example, the author deduces the addition formulæ and a new formula in Bessel functions. References may be made to the author's published papers (Nouvelles remarques sur les function de Bessel du troisieme ordre, *Acta. Pontif. Acad. Sci.* Novi, Luncæi, 1931, **87,** 323 and Les fonctions hypergeometriques et le Calcul Symbolique, *Ann. Soc. Sci.*, Brux, 1933, **A53,** 103).

N. S. N.

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EXERCISES IN SECOND YEAR CHEMISTRY. A Manual of Theoretical and Analytical Procedures. By William H. Chapin, Third Edition. Revised and Enlarged. (Published by John Wiley & Sons.) Pages 253. Price 15*s.* 6*d.*

This book is meant to be a companion volume to the author's *Second Year College Chemistry.* The author has dealt with a variety of topics of physico-chemical and analytical interest under two main divisions: (1) theoretical exercises, (2) quantitative analysis. In Part I a series of experiments in Physical Chemistry not involving difficult technique or complicated apparatus have been described which go a long way to a clear understanding of the subject on the part of a beginner. The reviewer would like to draw attention to the elegant experiments in the chapters on Avogadro Number, neutralisation indicators, etc. Coming to Part II which deals with quantitative analysis mention should be made of the excellent theoretical background that is provided for the course in volumetric, gravimetric and electro-analysis. The chapter on pH, water-softening control, etc., is particularly interesting. Every topic treated in the book is followed by a number of problems and exercises.

The printing and get-up of the book are excellent. The pyroxylin-impregnated "water-proof" and "vermin-proof" binding is a novel feature. The book will be very useful as a reference volume to students studying for B.Sc. and Honours examinations.

M. SESHAIENGAR.

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MAN AND MEDICINE. *An Introduction to Medical Knowledge.* By H. E. Sigerist. Translated from the German original by Margaret Galt Boise. Pp. v+340. (London: George Allen & Unwin, Ltd.) 1933. Price 12*s.* 6*d.* net.

Although there are several monographs dealing with the theory and practice of medicine, there are few publications which deal with the subject in such a manner that even laymen can follow them. Prof. Sigerist's lucid presentation of the subject is therefore a welcome contribution.

The book covers the entire field of science in relation to medicine. The author skips on from one section to another without losing the thread of continuity. At each stage, the subject is made interesting by historical anecdotes which bring into relief the human interest underlying each discovery referred to by the author.

If the book has any defect, it is that the author is too ambitious, that he has endeavoured to cover a vast field of knowledge in the short space of 329 pages. Even technical readers, many of whom are unfortunately unacquainted with the historical development of their subjects, would like to linger over some of the sections and learn more about the various factors, human and otherwise, that led to the great discoveries in their respective fields. It would indeed have been highly desirable if the scope of the book had been restricted to a few select branches, the others being reserved for later publications.

The book has been written in excellent style and the translator deserves much praise for her efforts.

S. V.

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ELEMENTARY SCIENCE. (Parts I & II.) By James B. Guthrie, M.A., B.Sc. (Chambers Limited, Edinburgh.)

Part I. Pp. 112. Price 1*s*. 6*d*.

This is the first of a series of four books, by James Guthrie, Principal teacher of science and mathematics of Buckhaven Secondary School. These books are in accordance with the most recent circulars of the Board of Education and the Scottish Education Department. Part I deals with subjects like Expansion and Contraction, Thermometry, Solution and Crystallisation, Rusting of iron, Physical and chemical changes, Atmospheric pressure and transfer of heat. The book is written in very simple language. Experiments precede generalisations and definitions. Difficult terms are explained at length. Experiments are designed to be simple and capable of being tried by the enquiring student. Hints to the teachers are given here and there. The figures indicating apparatus used for experiments are drawn in a neat and attractive manner. The portions dealt with in the book are meant to be covered in a year with four periods a week.

Part II. Pp. 127. Price 1*s*. 8*d*.

This book is meant to cover the science syllabus of the second year in schools and deals with subjects like Force, Centre of Gravity, Density, Pressure, Machines Work, Latent Heat, Action of Metals on the common acids. Preparation and properties of hydrogen and composition of water, Questions and Exercises and Answers to them are given.

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B. V. SASTRY.

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## Forthcoming Events.

*The Central College Mathematical Society, Bangalore.*—Fortnightly Lectures on "Introduction to the General Theory of Algebraic Numbers" by Mr. K. Venkatachala Iyengar.

Fortnightly Lectures on "Quantum Mechanics" by Prof. B. S. Madhava Rao.

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## Erratum.

Vol. III, No. 3, page 106, Col. 2, line 8, *for* P. F. MALLIK *read* P. C. MALLIK.

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CONTENTS.





## Sir James Jeans and the New Physics.

THE Presidential Address of Sir James Jeans before the British Association is a fascinating piece of work. Most of it is taken up with a presentation of those aspects of modern physics which have influenced modern scientific outlook—as envisaged by Jeans. In the first place, he makes a clear-cut distinction between the methods of the classical physicist and of his modern successor. The former was keen on trying to construct a mental picture whose elements were derived from objects of every-day experience such as 'billiard balls, jellies and spinning tops'. It is because of this tendency on the part of the 'old-fashioned' physicist to visualise a concrete model in his explanation of phenomena, that classical theories or modifications of such theories on classical lines could not be made to embrace the new facts of observation. According to Jeans the changed outlook of the modern physicist consists in the following:—The content of a set of physical measurements is a set of numbers, each number being a ratio. For instance, to take an example given by Jeans, when we say that the wave-length of a certain radiation is so many centimetres we mean that it is a certain multiple of a centimetre, and since we do not know or rather can never know what a centimetre is in itself, the significant fact in the statement 'so many centimetres' is only its numerical part. Once we concede this, it naturally follows that our theoretical picture of the phenomenal world, which consists in synthesising measured data must be mathematical in form.

The solid rock on which the modern physicist builds is ascertained fact and the bricks used in the construction are the 'observables'. For instance, in the wave theory of light, the solid fact is represented by the word 'wave', and the ether with which the classical physicist filled space, space itself and time, are man-made decorations and do not form part of nature. The same is the lot of the space-time continuum of the theory of relativity, for the General Theory shows that it 'can be crumpled and twisted and warped as much as we please without becoming one whit less true to nature—which of course can only mean that it is not itself part of nature'. The entire knowledge of the outer world comes to our minds through the

frame-work of space and time and their product the space-time continuum, as it affects the senses. However important the frame-works may be, they do not form part of nature but are purely mental constructs. The same is the fate of matter. It is as much a pure assumption as ether and is an 'unobservable'. Classical Physics was based on the hypothesis that matter existed in space and that its history was mechanistically determined for all time, time being independent and objective. The cardinal weakness in this outlook of the classical physicist was that the rôle given to the mind was that of a passive onlooker without any influence on what it observed. According to Jeans, what the modern physicist has set before himself is the task of studying the impressions that he gets through 'the gateways of knowledge' (*i.e.*, the senses) and not what lies beyond. He is concerned with appearance rather than with reality. In ordering these impressions he adopts two pictorial methods. In one he pictures particles in space and time, in the other, the picture is a system of waves; the former provides for our bias inherited from Classical Physics, while the latter is intended to provide an answer to the question 'what is going to happen next?' Jeans dubs the two modes of looking at the physical world, (which world, as he has already told us, consists only in the impressions which we get through the senses) parables, to prepare us for any inconsistency that may turn out to exist between the two pictures, for parables are not to be interpreted too literally. The thesis is developed on these lines with illustrations from the findings of modern physics, the several parts of the thesis often being not in perfect harmony with one another. The burden of the song may be summed up in the words of Jeans himelf: 'The old physics imagined it was studying an objective nature which had its own existence independently of the mind which perceived it, which indeed had existed from all eternity whether it was perceived or not.' But in the new physics nature consists of waves and these are of the general quality of waves of knowledge, or of absence of knowledge in our minds.

To those who are familiar with the writings of Jeans the distinctly subjective trend which he gives to the findings of modern Physics will not appear strange. He says, "If we ask the new Physics to specify an electron for us, it does not give us a mathematical specification of an objective electron but rather retorts with the question, 'How much do you know about the electron in question?' We state all we know, and then comes the surprising reply, 'that is the electron'. Here the electron itself is not part of nature and our knowledge of it ultimately resolves itself into a set of numbers synthesised into one or more mathematical formulæ. The numbers themselves are ratios of physical quantities incomprehensible in themselves. Thus it turns out that our knowledge of the electron in the 'parable' is purely mathematical, nay, more, this mathematical content of our knowledge is the electron. The modern physicist's knowledge of nature is, according to Jeans, to be identified with the mathematical formulæ which he constructs from physical measurements. The question naturally arises whether the earth, sun, moon and stars which the ordinary man thinks exist in space and time, have any existence apart from the respective mental impressions. The answer to this question would be in the negative if we interpret literally the following thesis in the address: 'The earthquake waves which damage our houses travel along the surface of the ground, but we have no right to assume that they originate on the surface of the ground; we know on the contrary that they originate deep down in the earth's interior.' Applying the analogy, the sensory impressions which we have of familiar things do not have their origin, as we think they have, in the sun, moon and stars, which we think we see, but somewhere else, presumably in the mind itself. But if this be so, the main objection to subjective idealism arises, *viz.*, how is it that all of us see the same sun, moon and stars? To this difficulty Jeans suggests an answer. In the particle picture we think of individual particles, electrons and so on, existing in space and time; as far as we know, in the truer wave picture, the individuality of the particles is lost. As we think ourselves to be existing in space and time we retain our individuality, but if we transcend space and time we perhaps form parts of a single stream of life, where apparently individuality is lost. "It is only a step from this," says Jeans, "to a solution of the problem which would have commended itself to many philosophers, from Plato to Berkeley, and is, I think, directly in line with the new world-picture of modern Physics." It is no

doubt true this is only a suggestion, but is the suggestion in the right direction and does it naturally lead to Berkeley's Subjective Idealism? To Berkeley the objects of every-day observation on examination turn out to be ideas in the perceiver's mind. For an object to exist is to be perceived. In order to account for the sameness of the objects perceived by a number of observers Berkeley introduced the hypothesis of God in whose mind all objects exist as ideas and our ideas are replicas, so to speak, of the ideas in the mind of God. If we take away God whose existence Berkeley assumed, the difficulty that all of us see the same sun and moon remains unexplained. Moreover to Berkeley individual personalities were not indistinguishable ingredients of a stream of life, as is the case with the electrons in an electron current. In fact, no satisfactory answer to the fundamental difficulty which one encounters in all forms of extreme subjective idealism, has yet been offered by any philosopher; neither does modern Physics indicate a satisfactory way of meeting it. To Sankara, the famous Indian philosopher, both our perceptions and the things perceived are illusory appearances spread over an unchanging underlying reality. Our perceptions have no higher degree of reality than the things perceived. So in his system the idea that all persons see the same objects is in the mind and therefore is itself illusory.

'The old physics,' says Jeans, 'imagined it was studying an objective nature which had its own existence independently of the mind which perceived it which indeed had existed from all eternity whether it was perceived or not.' One would infer from this that there is no objective world existing independently of the perceiving mind. How different from this attitude is the view of Max Planck—one of the most prominent among the makers of modern physics! Says Planck: "A science that starts off by predicting the denial of objectivity has already passed sentence on itself." According to Planck one of the fundamental theorems of physical science is that there is a real world which exists independently of our act of knowing. So the reader of Jeans' fascinating address must not forget that there are prominent physicists who differ fundamentally from him on the philosophical implications of the revolutionary changes that have taken place in the domain of Physical Science.

## The Stratosphere Balloon and its Use in Scientific Research.

THE investigation of the free atmosphere by means of sounding balloons carrying self-registering instruments has established that the mixing of the atmosphere due to convective processes extends on the average to a height of about 17 km. near the tropics and to about 9 km. near the poles. Above these levels, the atmosphere is extremely stable for vertical movements, the temperature increasing with height near the tropics and remaining more or less stationary up to 25 km. in temperate and polar regions. The upper stably layered region of the atmosphere is called the stratosphere. The temperature at the base of the stratosphere is about −80°C. near the equator and about −50°C. near the poles.

Among the great scientific achievements of the present decade must be included the stratosphere balloon ascents of the Belgian scientist Professor Piccard and his collaborators. The principal motive for Professor Piccard's adventure was the study of cosmic radiation more thoroughly and precisely than was considered possible by other methods. The repetition of these ascents in other lands with similar balloons and technique and extended programmes shows that voyages into the stratosphere for scientific research have come to stay and that it is only a question of time before power-driven commercial machines will fly through the clear, cloudless air of the stratosphere with speeds not far short of that of sound.

Piccard's own account of the bold and successful flights carried out by himself and his colleagues is contained in his very interesting book *Auf 16,000 Meter-Meine Fahrten in die Stratosphäre* (Schweizer Aero-Revue, Zürich). The essential new feature of Piccard's flying equipment was the substitution in place of an open cabin of an air-tight gondola for the accommodation of the aviators and their measuring instruments. The gondola was spherical in shape, made of aluminium and had a diameter of 2·1 metres. It was provided

with two man-holes and eight small windows through which the balloonists could obtain a view of the outside world. For the regeneration of the used-up air inside the cabin, arrangements were made to let into the cabin out of a compressed oxygen cylinder two litres of gas per minute and to remove, by absorption in alkali, the carbon dioxide produced by the respiration of the passengers. The aviators could thus practically carry their own atmosphere with them and avoid all physiological difficulties due to the low pressure at the higher altitudes. With a view to regulating the temperature of the air inside the cabin, Piccard painted one half-side of the gondola black, leaving the other half bright. By means of a propeller actuated by an electric motor, he planned to turn the balloon round a vertical axis so as to expose either side of the gondola towards the sun. Unfortunately, during the first flight, the arrangement did not work and the gondola had its dark half facing the sun throughout the morning so that the temperature inside got uncomfortably high 25-34°C., although the outside temperature was −55°C. In the second ascent, the gondola was painted white and the result was that the temperature did not rise above 0°C !

The volume of Piccard's balloon, when fully inflated, was about 14,000 cubic metres and when full of hydrogen at a height of 16 km. (where the pressure is about 1/10 of that at the earth's surface) could sustain a total weight of 2100 kg. At starting, it was filled only to a fifth of its capacity.

Piccard and his collaborators carried in their balloons experimental equipment for measuring the intensity of cosmic rays both from the current produced in an ionisation chamber and from the enumeration of discharges in a Geiger counter. They also carried apparatus for measuring the effect of screening on ionisation and for determining whether there was any directional variation of the intensity of radiation. The intensity measurements confirmed in general the results obtained by Regener from his sounding balloon experiments carried out a few days before Piccard's second flight. Both investigations showed that above 13—14 km. the rate of increase of intensity of cosmic radiation decreases with height and the intensity tends to reach a constant value at the outer limits of our atmosphere or even to show a decrease. The experiments with the Geiger counter showed that there was no appreciable variation of the intensity with direction. It would take us too far to discuss the significance of the cosmic ray measurements here.

Piccard's ascents were followed by the ascents of "Stratostat U.S.S.R." from Moscow in September 1933. This reached a height of 18,500 metres. Another remarkable ascent was organised in the United States of America in connection with the *Century of Progress* Exposition in November 1933. Professor Piccard collaborated in it. The balloon reached a height of 18,665 metres. Besides experiments on cosmic rays, measurements were also attempted with varying degrees of success on the transmission of the atmosphere for the solar spectrum with a quartz spectrograph, on the colour and polarisation of sky-light, on the photographic visibility of the earth using ordinary and infra-red light, on the intensity, range and freedom from static of radio signals transmitted from great heights, on the viability of spores exposed to conditions prevailing in the stratosphere, etc. The detailed scientific results of the ascents will be awaited with eagerness by workers all over the world.*

K. R. R.

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* A. H. Compton, "Scientific Work in the *Century of Progress*: Stratosphere Balloon," *Proc. Nat. Acad. Sci.*, 1934, **20**, 79.

# Some Recent Advances in Indian Geology.*

By W. D. West,

*Geological Survey of India.*

## 2. Deccan Trap Volcanic Activity.

In India we have one of the best developments extant of the 'plateau basalt' type of igneous activity, known as the Deccan Trap. The importance of a thorough study of these rocks will readily be appreciated when it is understood that in the opinion of many geologists the basalt, which is the predominant type in this series of rocks, is probably the primitive rock from which most other rock types have been evolved by some process of differentiation. The remarkable similarity in chemical composition which all plateau basalts throughout the world exhibit suggests that they have been derived directly from some primitive source without the intervention of any process of differentiation, and their study is, therefore, of great importance in relation to several branches of geology. So far, considering the very great area which these lavas cover in India, the extent to which they have been studied in detail is lamentably small. Their study is conveniently divided into two sections. On the one hand we have the immense thickness of horizontally bedded basalts and dolerites which make up the greater part of the Deccan Trap, and which are typical 'plateau basalts'. These show, even in detail, great uniformity of character, though certain slight differences in chemical composition can be discerned between the earlier and later outpourings. On the other hand, there occur certain areas along the north-west corner of the Deccan Trap outcrop, notably in Gujerat, Kathiawar and Cutch, in which differentiation has proceeded along special lines to an advanced stage giving rise to a great variety of rock types. It is essential for a complete understanding of either of these groups that both should be studied.

The most important contribution to our understanding of the petrography of the rocks of the former category has been provided by Dr. L. L. Fermor, whose study of the lavas penetrated by a deep boring at Bhusawal, some 250 miles north-east of Bombay, has provided us with an accurate statement of the petrography of these rocks.[1] In a study of the 29 flows penetrated, it is shown that the predominant type of rock is a basalt or dolerite of specific gravity 2·91, consisting essentially of labradorite felspar ($Ab_1\ An_2$), enstatite-augite (pigeonite), iron ore and glass, while olivine, always completely altered, occurs in 18 out of 29 flows. This description may be regarded as typical of the greater portion of the flows of the Deccan Trap of India. In this paper particular attention is paid to the minerals of late crystallisation, occurring either as linings and infillings to the amygdales of the flows, or as alteration products of the glassy base and of some of the minerals. To the former group belong the minerals chlorophæite, delessite, chalcedony, opal, quartz and lussatite, and the zeolites heulandite, apophylite and ptilolite, with calcite; while to the other group belong palagonite, chlorophæite, celadonite, chabazite, together with iddingsite, delessite and serpentine which are pseudomorphous after the olivine. The conclusion is reached that, with the possible exception of the calcite, these minerals have been formed during a late stage in the final consolidation of the lavas, and have not been deposited by meteoric waters. This is the first time these minerals of late crystallisation have been adequately described. Both in this and in subsequent papers the process known as 'palagonitisation' is discussed in detail,[2] a subject which also receives attention in a paper by D. N. Wadia.[3] Finally, a further point brought out by Dr. Fermor is that in a number of the flows the olivine, and sometimes the labradorite, phenocrysts have sunk to the base of flows which were apparently more fluid than the rest at the time of eruption. This observation of the sinking of the crystals leads the author to suggest that the ultrabasic rocks found occasionally in the Deccan Trap, such as in Baluchistan, may have originated by some such mode of gravity differentiation, a point which is referred to again below.

* Published with the permission of the Director, Geological Survey of India.

1 *Rec. Geol. Surv. Ind.*, 1925, **58**, 93.

2 *Op. cit.*, 1928, **60**, 411; and *Geol. Mag.*, 1931, **68**, 266.

3 *Rec. Geol. Surv. Ind.*, 1925, **58**, 338.

In 1916 Drs. L. L. Fermor and C. S. Fox published an account of the Deccan Trap lava flows near Linga in the Chhindwara district, Central Provinces, with a map showing the distribution of five separate flows. Specimens representing four of these flows have now been analysed and the results discussed by Dr. Fermor.[4] Although of the four specimens analysed two are basalts and two are dolerites, the analyses are all very similar. It is only when the norms are calculated that slight differences are brought out. These show that from the lowest to the highest flow the direction of change is increasing alkaline felspars, increasing total felspars, and increasing total pyroxenes, with decreasing total iron ores. When compared with the norm of the eleven analyses of Deccan Trap made by Washington, after arranging these latter into their probable order of extrusion, it is found that the differences in composition as one ascends in the Traps is similar in direction but much larger in degree than that shown by the four specimens. From this it is deduced that the tendency to differentiation illustrated by the lavas of Linga on a small scale is an epitome of that generally applicable to the lavas of the Deccan Trap series as a whole.

As regards the field relations of these plateau basalts and their associated dykes and sills, a good deal of work has recently been done by H. Crookshank along the northern slopes of the Satpura hills, in the north Chhindwara and south Narsinghpur districts, where both the field relations and the petrology of these rocks present many features of interest. A memoir on this area is shortly to be expected. The chief interest of the area concerns the abundant intrusive sills and dykes. Generally speaking, the high ground to the south and east of the area is occupied by Deccan Trap, and the low ground to the north and west by Upper Gondwana rocks. And although the sills are found to some extent in the southern area intruded between the basalt flows, they attain their grandest development in the Upper Gondwanas. The dykes are frequently composite and vary from fine-grained basalts to coarse-grained porphyritic dolerites. The sills are only very rarely composite, and are nearly all coarse-grained somewhat porphyritic dolerites. Normally the minerals of these rocks are the same as those described by Dr. Fermor from Bhusawal, but there are also interesting variations. The sills, which are frequently several hundred feet thick, show well the phenomenon of the sinking of the olivine crystals, though not of the labradorite. In some cases not only has olivine sunk but a cryptocrystalline residue, representing the last part of the magma to consolidate, is concentrated in the upper parts of the sills. This latter contains primary quartz and micropegmatite. Quartz cannot of course crystallise in the presence of olivine; but the removal of olivine by sinking has evidently allowed crystallisation to proceed along lines favouring the formation of quartz, and the observation is of more than local interest. In one or two cases biotite was found partially altered to chlorophæite, and Mr. Crookshank suggests that this mineral may once have been more abundant, but has in most cases been destroyed by the palagonitisation. One dyke, which has been traced intermittently for eight miles, deserves special mention. It is a porphyrite consisting of oligoclase, quartz, enstatite, augite, hornblende and micropegmatite, with an $SiO_2$ percentage of 63. Nothing like it has hitherto been noted in the Central Provinces.

Coming now to the second portion of our subject, we have to deal with a large variety of rock types, some very basic, some very acid, and others markedly alkaline, which are found mainly in the peninsula of Kathiawar and the adjacent country. These rocks are definitely part of the Deccan Trap volcanic episode, but represent the results of advanced differentiation localised about certain areas or along certain lines. Ever since the days of F. Fedden[5] it has been realised that the peninsula of Kathiawar was exceptional in containing several foci of eruption in which differentiation had proceeded to yield a large variety of rocks. So long ago as 1893 Dr. J. W. Evans made a collection of rocks from Junagarh State, and subsequently published a paper describing one of them, a monchiquite containing primary analcite, which he found on the margin of a nepheline-syenite.[6] Recently one or two of his students have re-examined this collection and shown it to be very varied. M. S. Krishnan has made a detailed petrographical study of those collected from the Girnar and Osham hills.[7] Of these the

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4 *Rec. Geol. Surv. Ind.*, 1934, **68**, Pt. 3. (in the Press).

5 *Mem. Geol. Surv. Ind.*, 1885, **21**, 73.

6 *Quart. Journ. Geol. Soc.*, 1901, **57**, 38.

7 *Rec. Geol. Surv. Ind.*, 1926, **58**, 380.

majority are nepheline-syenites and dolerites, but other less common types include quartz-porphyry, syenite porphyry, syeno-diorite, diorite-gabbro, porphyrite, andesite, olivine-gabbro, lamprophyre, limburgite, obsidian, rhyolite and pitchstone. In this paper six new analyses are given, which the author considers indicate a petrographical province of the 'Atlantic' type. At about the same time K. K. Mathur, V. S. Dubey and N. L. Sharma published a small-scale map of the rocks of Mount Girnar, representing the first attempt to map this focus of eruption. In the accompanying paper intrusions of olivine-gabbro, diorite and monzonite, granophyre, and nepheline-syenite are described.[8] These are intruded into typical Deccan Trap lavas which they have domed up forming Mount Girnar. Although there is apparently no direct evidence of the mode of origin of these rocks, reasons are given for supposing them to have been derived by differentiation *in situ* through progressive crystallisation, estimates being given to show that the parental magma was of intermediate or dioritic composition. It is thought that crystal settling through gravity has not been operative. More recently, other rocks of Dr. Evans's collection, from the West Gir forest, have been described by S. K. Chatterjee.[9] These are mostly basic dykes, chiefly olivine-dolerites, but mention is also made of irregular intrusions of acid rocks consisting of spherulitic granophyre, pitchstone, rhyolite and other types. Seven new analyses by the author are given. Other more general papers which include references to the Deccan Trap of Kathiawar, and which are not generally known, are E. Howard Adye's two memoirs on the "Economic Geology of Navanagar State"[10] and on the "Economic Geology of the Porbandar State",[11] which are illustrated by a large number of photomicrographs; and a paper by K. P. Sinor on the "Igneous and Sedimentary Rocks of Bhavnagar Territory,"[12] also illustrated.

As regards the more acid types of rock, which have been known to occur in the Deccan Trap ever since W. T. Blanford published his observations on the geology of the Tapti and Lower Narbada valleys,[13] K. K. Mathur and P. R. J. Naidu have recently described some acid intrusions and lavas on the coast north of Bombay comprising trachytes, granophyres and rhyolites.[14] These include the "granophyric trachyte" of Kharodivadi described by M. S. Krishnan.[15] Associated with these rocks are glassy gabbros and dolerites. As a result of calculating the silica percentage of the glassy base of these rocks, shown to be about 68%, the authors are led to believe that the acid intrusions represent the same glassy base after it has separated from the partly crystallised magma and solidified away from it. They further conclude that these acid intrusions are a very recent phenomenon. Subsequently, in his presidential address to the geology section of the Indian Science Congress, 1934, Mathur brought together all known occurrences of both acid and very basic rocks of Deccan Trap age, and discussed briefly their origin and age.[16] He suggests that the acid types occur mainly along two lines, one running north and south, from Pavagad hill in the Panch Mahals in the north, to Bombay Island in the south, and one running east and west, along the Narbada valley to as far as Barda hill in Porbandar State in Kathiawar. He further suggests that their origin may be due to the assimilation of acid rocks by the molten basalt, basing his conclusions on certain observations made by W. T. Blanford and P. N. Bose. His view, however, that the rhyolite on Pavagad hill is an intrusion has now been shown to be incorrect, A. M. Heron having confirmed the original view of Dr. Fermor that it is a flow capping the hill and part of the general succession of lavas.[17] As regards the age of these rocks, while recognising the possibility that in certain cases both the acid and the very basic types were extruded at the beginning of the Deccan Trap period, he inclines to the view that for the most part they are very recent in age, attributing their age in some cases to a period subsequent to the establishment of the present

8 *Journ. Geol.*, 1926, **34**, 289.
9 *Op. cit.*, 1932, **40**, 154.
10 E. H. Adye, *Memoir on the Economic Geology of Navanagar State*, Bombay, 1914, 262.
11 E. H. Adye, *Reports on the Economic Geology of Navanagar State*, Bombay, 1917, 198.
12 K. P. Sinor, *Petrographic Descriptions of the Igneous and Sedimentary Rocks of the Bhavnagar Territory*, Bombay, 1927, 72.
13 *Mem. Geol. Surv. Ind.*, 1869, **6**, 163.
14 *Malaviya Commemoration Volume*, 1932, 787.
15 *Rec. Geol. Surv. Ind.*, 1929, **62**, 371.
16 *Proc. 21st Ind. Sci. Congr.*, Bombay, in the press.
17 *Rec. Geol. Surv. Ind.*, 1934, **68**, 17-18.

topography, a conclusion which perhaps some geologists will find it difficult to accept.

It was mentioned above that Dr. Fermor had suggested means whereby the ultra-basic rocks of Deccan Trap age, such as those in Baluchistan, might have been derived from the normal basaltic magma by the sinking of some of the phenocrysts. Further light has been thrown on this problem by W. D. West, who has examined the cores of rock brought up by deep borings put down through Deccan Trap lava flows in different parts of Kathiawar.[18] These rocks include very basic types such as limburgite and ankaramite, interbedded with the more normal Deccan Trap type of basalt. A study of the phenocrysts of olivine, augite and felspar found in these very basic lavas shows that in each type of rock the composition of the phenocrysts is closely related to the composition of the rock in which they occur. Thus the felspar phenocrysts in the more basic types are bytownite-anorthite as compared with the medium labradorite which occurs in the normal Deccan Trap basalt, while the olivines are more magnesian and the pyroxenes more calcic than those found in the normal basalt. These facts are thought by West to show that the different rock types did not originate during the Deccan Trap volcanic period by the sinking of phenocrysts as they crystallised from the basalt, since the phenocrysts differ markedly in composition from those found in the basalt; but that differentiation of the basalt took place long before Cretaceous times, and that the various rock types so formed were already available for extrusion when re-melting took place during Upper Cretaceous times.

There is clearly still a large field for research into problems of Deccan Trap volcanic activity, and it is a field which is admirably suited to research by those unattached to official surveys. It must, however, be controlled by detailed and accurate field work, aided by chemical analyses, if it is to be of any real value.

[18] *Rec. Geol. Surv. Ind.*, 1934, **68**, 17.

[19] *Op. cit.*, 1932, **66**, 18.

## Chalcolithic Civilisation.

THE explorations carried out between the years 1928-1931 by Mr. N. G. Majumdar of the Archæological Survey of India have resulted in the discovery of sites on the western banks of the Indus which are reported to be older than Mohenjo-daro in the Indus valley. The people who lived in these areas had not attained any considerable prosperity, for apparently the hilly tracts which they occupied were neither fertile, nor rich in mineral resources. Their dwellings appear to have been constructed out of crude materials such as reeds and wood on a stony basement, and burnt bricks were practically unknown to them. At two places, Ali Murad and Khotras, the remains of the fortified places which have been unearthed, reveal walls built of stones which are in contrast with similar structures composed of bricks in Mohenjo-daro. The hillmen, the lake dwellers and the river inhabitants appear to have known the art of making pottery on the wheels for domestic purposes. Mr. Majumdar in his report draws attention to the fact that these utensils are capable of being divided broadly into four classes, a classification which he bases on the scheme of colouration, their geometrical shapes, the paintings on their surface and on the degree of polish. Compared with such finds in Mohenjo-daro and Harappa, the Chalcolithic vessels point to an earlier civilisation of great historical importance, of a race of people contemporaneous with the races who dwelt in Baluchistan, Persia and Mesopotamia in the third and fourth millennium B.C. Near the lake Mancher and at the upper levels of Jhukar and Lohumgo-dara, the excavations have brought to light a class of pottery which illustrates the later phases of Mohenjo-daro culture. We await the publication of fuller details of these extremely interesting pre-historic sites.

# Observations on Some Plant Abnormalities in Bengal.

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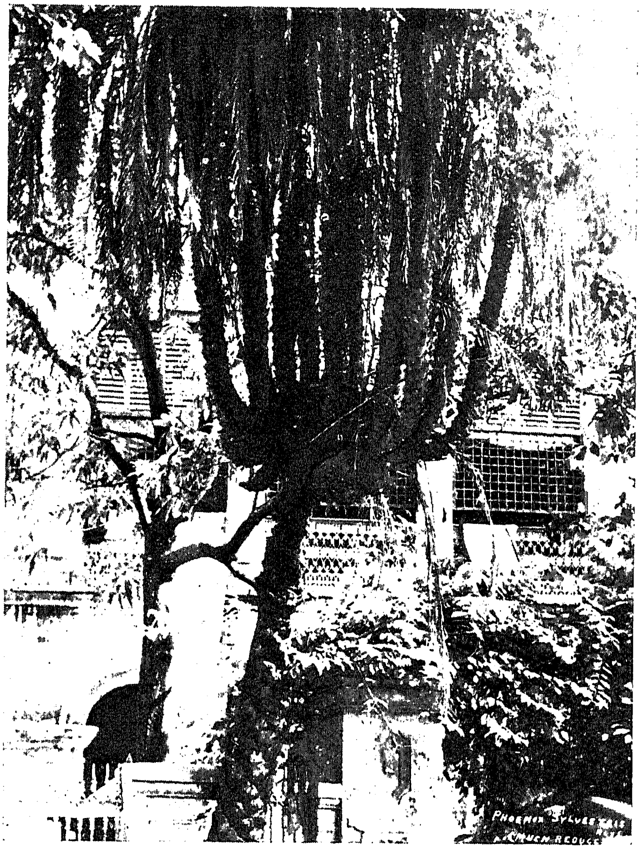
ABNORMALITIES of various types have been observed in a large number of wild and cultivated species of plants in Bengal. Of such may be mentioned fasciated flowering branch of *Achras Sapota* as shown in Fig. 1. Fasciation of *Tagetes patula*, *Mirabilis jalapa*, *Amaranthus* sp. and *Celosia* sp., and many other species are not of rare occurrence. A branched inflorescence of *Lagenaria vulgaris*, received recently, developing from the root stock is an interesting specimen for study. This abnormal branched inflorescence bears a large number of flowers in aggregation. Investigation is being carried on to trace the factors which led to such a peculiar abnormal basal inflorescence in Cucurbitaceæ. Sections of stems, flowers and fruits do not, however, show anything abnormal. Formation of fasciated structures and other similar monstrosities is often considered to be due to local damage or excess of nourishment at the growing organ either by attack of gall-insects or other agencies. Examples of abnormal flowers of *Hibiscus rosa-sinensis*, *Dianthus* sp. and other horticultural species are many. Flowers borne on the axil of the petals of a single flower and also sterile double flowers due to branching of the thalamus in *Hibiscus rosa-sinensis*[1] are not of rare occurrence. Viviparous seeds of non-mangroove species such as *Zea Mays*, *Mangifera indica*, *Artocarpus integrifolia* are also not uncommon. Double fruits of *Citrus decumana* and double and quadruple fruits of mangoes (*Mangifera indica*)[2] and brinjal (*Solanum melongena*) sometimes in the form of bifurcating horns are many. A syncarpous fruit of Cocoanut palm (*Cocos nucifera*) has been received of late years for an exhibit in the gallery of the Industrial Section of the Indian Museum. Polyembryony in the genus Eugenia has been recorded by Tiwary.[3]




Branched *Phœnix sylvestris*.

On rare occasions, evidently due to stimulus from local injury at the apices of the stem, crowds of branches develop forming a crown on palm stems. Such a specimen of *Phœnix sylvestris* exists in Southern Calcutta in the courtyards of a residential house. The tree which is still alive is about sixty years old and some of the branches are since dead. The branches come out mainly in two lateral directions and vary from 4 to 5 feet in length, each bearing the usual crown of leaves. Each of these heads in its turn bears also flowers and fruits in proper season, as shown in the photograph I.

[1] Banerjee, S. C., "Terretological branching of the thalamus of a species of Hibiscus," *Proc. Sixteenth Ind. Sci. Congress*, 1929, 228.

[2] Singha, B. N., "Notes on the Terretology of certain Indian Plants," *Jour. Ind. Bot. Soc.*, 1931, **10**, 160.

[3] Tiwary, N. K., "On the Occurrence of Polyembryony in the genus Eugenia," *Jour. Ind. Bot. Soc.*, 1927, **5**, 124.

An interesting specimen of a branched inflorescence of *Musa sapientum* var. *paradisiaca* has recently been observed in a plant growing in the village Gobardanga of 24 Pergunnahs. This plant, as illustrated in the photograph II, has a long inflorescence bearing a large number of spikes which are pedicelled. Thus the inflorescence appears like a branched panicle, each branch bearing a branch of three stalked spikes. The inflorescence carried a total number of about 22 spikes and some of them were bearing green fruits. Syncarpous fruits are also observed which is, as known to the plant terretologists,[4] due to mutual pressure in the position of the flowers in the inflorescence. A branched inflorescence in *Musa sapientum* was previously reported by Messrs. K. G. Banerjee and G. P. Mozumdar. They made a note in the abstract of papers of the *Proceedings of the Sixteenth Indian Science Congress*, 1929, "on the branching of the main axis and development of 105 perfect and semi-perfect inflorescences in the places of flowers in the axils of spathes on the main axis." Costerus and Smith[4] in their studies of tropical terretologist, 1915, recorded a branched inflorescence in *Musa paradisiaca.* The same authors have also reported that the branched inflorescence bears flowers and fruits in the following year, if the axis of the inflorescence remains on the plant. *Musa paradisiaca* and other Musa species such as *Musa ornata* are susceptible to various types of abnormal growths of the floral structure of the flowers as reported by H. Crüger.[4] Parthenocarpæ[4] is also common and has, more or less, been thoroughly studied by various authors together with their anatomical details. Monstrosities such as an inflorescence bursting out from the base of the crown of leaves is not of rare occurrence as once reported by Mr. S. C. Banerjee, Professor of Botany, Presidency College, Calcutta. Abnormalities of the flowers of *Musa superba* and *Musa paradisiaca* were also noted by Agharkar.[5] It is indeed a matter of some importance to note that such branched inflorescence in Musa can bear fruit. The question is the quality of the fruits borne. If by horticultural experiments such branched inflorescence in Musa may be allowed to bear fruits of good quality and of sufficient market value, it means a good headway in the study of horticulture. *Musa paradisiaca* Linn. was formerly considered as a separate species. It was subsequently included by Hooker in *Musa sapientum*

Branched inflorescence of *Musa sapientum*, var. *paradisiaca.*

Linn. which Prain,[6] agreeing with Hooker[7] has rightly considered *paradisiaca* Hook., a variety of *Musa sapientum* Linn. *Musa sapientum* Linn. var. *Paradisiaca* Hook. which is wildly cultivated in Bengal is commonly known in Bengali as Kanchkala. The systematic position of various types of cultivated bananas is not yet quite fixed although attempts are being made by a large number of systematists and horticulturists in this direction. Wild bananas have also been taken into account.

In 1929, one of the papaya (*Carica Papaya*) plants grown in the compounds of the writer inside the Royal Botanic Garden, Calcutta, exhibited, on one of its leaves, a peculiar superposed leaf-structure

[4] Penzig, O., *Pflanzen-teretologie*, 1922, **3**, 325.

[5] Agharkar, S. P., "On the abnormalities of the flowers of *Musa superba* and *Musa paradisiaca* sub sp. *sapientum*," *Jour. Ind. Bot. Soc.*, 1931, **4**, 18-20.

[6] Prain, D., *Bengal Plants*, 1903, **2**, 1050.

[7] Hooker, J. D., *Flora of British India*, 1894, **6**, 262.

with a stalk developing over the primary leaf-lamina appearing as an extension of the primary leaf-stalk (Fig. 2). Singh, who has recorded a large number of malformations from different provinces of India, mentioned in his note "On the terretology of certain Indian plants" VIII,[8] 'stalked funnel or spoon-like structures on the adaxial surface' of the leaf of *Carica Papaya*, 'just above the point of attachment of the petiole and the palmate lamina'. He evidently referred to a superposed leaf. Mozumdar in the *Proceedings of the Indian Science Congress*, 1929, considers similar superposed leaf formation as a case of enation, evidently, as his observation suggests, in want of a more suitable term. He, however, suggests a superficial nature of the growth of this superposed leaf the Colorado River Valley of Southern California. An otherwise normal leaf bore a secondary leaf-structure erected in double-deck fashion above the primary leaf-blade. The first sight of such a leaf gave a startling sense of novelty, though several plants in California were found to have such leaves, and many others in Southern Florida. A superposed leaf-structure should not be confused with twinning, fasciation, or other lateral modifications of leaf-blades, which have been reported from several families of plants. The Carica variation may be described as a vertical addition to the leaf, supported by a secondary petiole growing out of the callus of the primary leaf-blade (see Figs. 6 & 7). A special word seems necessary to characterise the

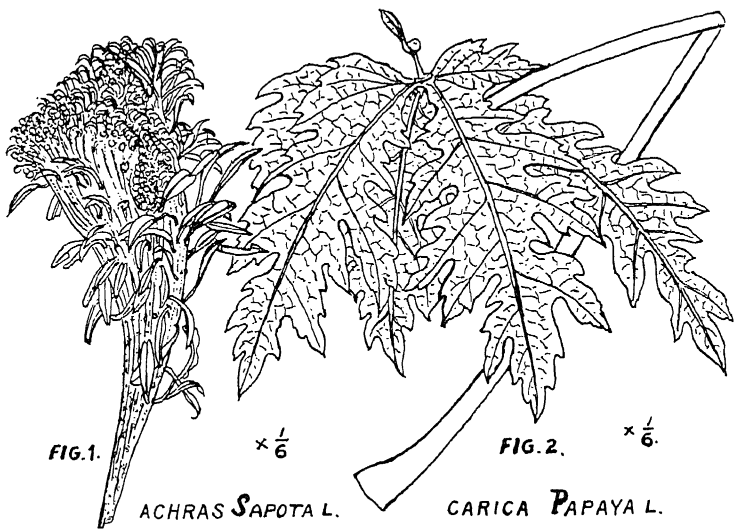



**Fig. 1.** Fasciated branch of *Achras Sapota*. **Fig. 2.** Superposed Leaf of *Carica Papaya*.

structure. This interesting variation in leaf structure of *Carica Papaya* has been discussed by Cook[9] very lately in his illuminating article entitled "Double-deck Papaya leaves—an example of leaf evolution". Cook rightly suggests a special term *superate* for such an overtopped, double deck leaf, with secondary leaf structure rising above the primary leaf-blade. Cook observes:—"A striking variation was found in 1932 in an experimental planting of papayas in

overtopped, double-deck leaf, with a secondary leaf-structure rising above the primary leaf-blade. Such a word as *superate* may convey the idea of a leaf surmounted by another leaf, as representing the morphological principle of adding new elements of leaf-structure by superposition. Setting one leaf on another may be considered as a method of derivation of compound leaves from simple leaves. The Carica variation illustrates a constructive possibility in leaf evolution that apparently has not been recognised in the past, but may be worthy of observation and experimental study."

Palm-shaped and other curiously shaped

[8] Singh, T. C. N., *Proc. 18th Ind. Sci. Cong.*, 1931, 270.

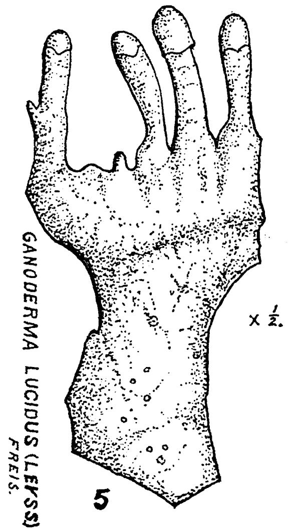
[9] Cook, C. F., "Double-deck Papaya leaves, an example of Leaf Evolution," *Jour. of Heredity*, 1934, **25**, 226.

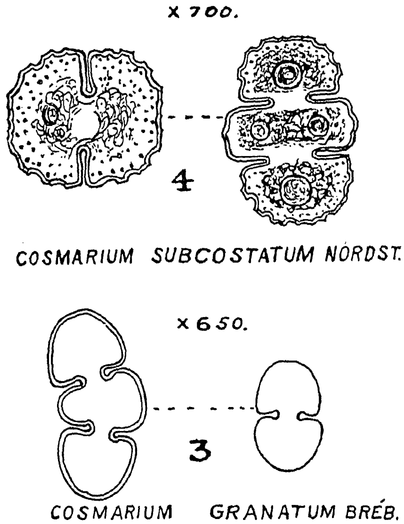
fruits of *Carica Papaya* and fruits containing sometimes two or three or as many as seven[10] fruits inside one fruit or one inside the other are of frequent occurrence.

It is suggested by Botanists and Horticulturists that seeds or grafts from the abnormal structure sometimes result in the development of similar abnormal individuals. Such an instance is well established in *Ficus Krishnii*, a horticultural species grown in the Royal Botanic Garden. But reversion to the parent form of *F. Bengalensis*, which may be called a *bud mutation*,[11] has actually taken place in one of the branches of this *F. Krishnii* as reported by the author in *Nature*. Details of this will be published in a subsequent note.

Medical College, Calcutta, a specialist in hard Fungi, possesses in his herbarium specimens of *G. lucidus* of various phantastic shapes. Such curious development is very likely due to obstruction in the development of the thallus and need not be taken as anything extraordinary.

Monstrosities or malformations are but freaks of Nature and may be considered as marked aberrant variations appearing suddenly in a plant body. They are by no means less common and to a botanist does not appeal so much. "The relationship between plant deformities and living organisms (ranging from bacteria to insects) was fairly common knowledge in serious horticultural circles before the present




**Figs. 3 & 4.** Abnormal growth of sister cells of *Cosmarium granatum* and *C. subcostatum*.
**Fig. 5.** "Hand of a Ghost," abnormal growth of the thallus of *Ganoderma lucidus*.

Abnormalities in Algæ and Fungi are also not very infrequently met with. Conjugatæ among algæ are well known for such variations from normal development. Thus Cosmarium species sometimes exhibit peculiar monstrous growth of sister cells (Figs. 3-4). Abnormal conjugation is also reported. A peculiar finger-like form of *Ganoderma lucidus* (Fig. 5) has aptly been designated by the collector as "Hand of a Ghost". Dr. S. R. Bose, Professor of Botany, Carmichael

century dawned. Kerner, in his *Natural History of Plants*, gives a very full account of the matter, while recognition of the cause of fasciation has now become so much an item of popular information as to entitle its mention in Webster's Dictionary." But laymen sometimes ascribe all sorts of explanation to a structure like that of "Hand of a Ghost" and it has been heard that they even go so far as to worship such a structure. Occasionally luminous fungi or bacteria emanating light from a log of rotten wood in a forest during the rains at night create similar surprise among villagers who consider them as a supernatural phenomenon. The actual factors connected with

[10] Mozumdar, G. P., "A Note on some Abnormalities in *Carica Papaya* Linn.," *Proc. Ind. Sci. Cong.*, 1929, 240-241.

[11] Biswas, K., "Bud mutation in Ficus," *Nature*, 1932, **130**, 780.

the production of malformations such as fasciation, etc., have not so far been thoroughly investigated in spite of fair accumulation of literature on this subject. Stoker[12] rightly observes: "A simple gall, such as that appearing on the oak, is due to insect injury to a differentiated tissue. Fasciation, which may be looked upon as a compound bud, or cluster gall, ensues from an invasion of embryonic material. Thus the fasciation of Asparagus really extends upwards (with the growing tip), not downwards. Excess of nourishment, as Mr. Mulligan surmises, has no connection whatever with the malformation. Mechanical injury, whether accidental (as from the growth coming in contact with an obstruction), or due to voluntary trauma (such as pinching out a growth) cannot cause fasciation, or anything resembling it, unless the wounds become infected." Perhaps detailed physiological, ecological and horticultural investigations may solve the problem in future.

[12] Stoker, F., "Fasciation," *Gardener's Chronicle*, 1934, **96**, 43-44.

# The Rôle of Silicon in Plant Nutrition.

By A. Sreenivasan, M.A.,

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EVER since Liebig first propounded his "mineral theory" of plant nutrition (1840), it has been generally recognised that certain elements like phosphorus, potassium, calcium, magnesium and iron are essential to perfect plant growth. During recent years, there has been increasing evidence to show that minute quantities of certain other elements like boron, fluorine, iodine, silicon, aluminium, manganese and zinc are also necessary. The parts played by many of the above-mentioned elements in plant nutrition have been more or less defined: those of others, especially that of silicon, are still comparatively obscure.

That silicon is always present in plants and forms a considerable proportion of their ash constituents is well known (Wicke,[1] Hattensaur,[2] Wolff,[3] Crüger[4] and others). Though the silicon content of different parts, especially that of leaves, is extremely variable, from the merest traces to over 80 per cent. of the total ash, still complete absence of that element is never observed.

This very general presence of silicon led to the belief that it is an essential nutrient to most plants; that it contributes to the stiffness of the tissues while its absence is the cause for the laying of crops after heavy rains. Later observations showed, however, that it cannot be placed in the same category as phosphorus or potassium as essential elements of plant nutrition, for a number of investigators (Sachs,[5] Knop,[6] Jodin,[7] Honnel[8] and others) working with different plants succeeded in demonstrating that silica can be completely dispensed with and that successive generations of crops can be grown to maturity in culture solutions without any supply of silicon beyond that provided by the original seed.

It is hardly likely, however, that a material which constitutes such a large percentage of the mineral constituents can be wholly without any use in the economy of the plant. Experience has indeed taught agriculturists that silica-free plants are at a disadvantage compared with those grown with the normal supply of that element. The latter are able to withstand insect pests and fungus diseases to a greater extent than the former.

Wolff and Kreuzhage[9] were probably the first to bring to light an entirely new aspect of the rôle of silicon in plant economy. These authors grew oats in culture solutions, with and without silica, and noted that in the former case there was considerable

[1] Wicke, W., *Bot. Zeit.*, 1862, **20**, 76.

[2] Hattensaur, G., *Ber. der Kais. Akad. der Wissenschaft, Wien*, 1890, **99**, **IIB**, 29.

[3] Wolff, E., *Aschen-analysen*, 1880.

[4] Crüger, H., *Bot. Zeit.*, 1857, **15**, 281, 297.

[5] Sachs, J. von., *Flora*, 1862, 52; *Exper. Physiol.*, 1865, 150.

[6] Knop, W., *Landw. Versuchs-Stat.*, 1862, **2**, 185; **3**, 176.

[7] Jodin, V., *Ann. Agron.*, 1883, **9**, 385; *Compt. rend.*, 1884, **97**, 344.

[8] Honnel, *Heberlandts wiss. prakt. Unters.*, 1877, **2**, 160.

[9] Wolff, E., and Kreuzhage, C., *Landw. Versuchs-Stat.*, 1884, **30**, 161.

increase in the proportion of grains formed, an effect precisely similar to that brought about by addition of phosphoric acid. They concluded that the actions of silica and of phosphoric acid are, in some way, related. This was supported by the field observations at Rothamsted where consistently increased yields were obtained on phosphorus deficient soil by the application of sodium silicate. After due consideration of these results and observations made in the course of special series of water-culture experiments, Hall and Morison[10] concluded that the beneficial effect observed on fertilisation with silicate is due to increased assimilation of phosphoric acid by the plant. They also adduced evidence to show that the related transformations occur in the plant and not in the soil. Gregoire[11] grew barley to maturity in nutrient solution and fonnd that on addition of 0·3 per cent. of silicate, there was decided increase in the yield of dry matter. He concluded that the increase was largely due to the absorption of silica by the plants and its consequent utilisation in growth. More than 43·5 per cent. of the ash of the plants receiving silicate consisted of silica while only less than 5 per cent. of silica was present in the ash of the controls. Similarly, Jennings[12] found an increase of 18–20 per cent. in the dry weight of wheat seedlings grown with 1 per cent. silica added to the nutrient solution and also an increase in the silica content of the plants.

Shedd[13] and Schollenberger[14] both observed that the effect of silicates in increasing growth is particularly marked in the case of soils deficient in phosphates. Lemmermann and Wiessmann[15] observed that even when no phosphate was added significant increase in crop yield could be obtained by application of silicates. They concluded therefore that colloidal silica has a direct effect on plant growth and that it acts in cases of phosphate deficiency by virtue of its ability to partly replace the latter in the plant. The analytical results showed, on the other hand, that the favourable action of silica could be correlated with increased assimilation of phosphoric acid by the plant (Lemmermann, Wiessmann and Sammett[16]). Lemmermann therefore abandoned his earlier views and explained his results by the hypothesis that silica exerts a solvent action on the phosphates present in the soil and renders it more easily available to the plant. His conclusions were criticised by Duchon,[17] while Nanji and Shaw[18] controverted his hypothesis stating that if phosphoric acid be absent, but an abundant supply of silica be available the latter should be able to take the place of phosphate without any detriment to growth; that conditions which are favourable for the assimilation of silica, may even suppress the intake of phosphoric acid, so that the supposition that in the absence of adequate supply of phosphoric acid silica has an indirect stimulating action on the plant is not borne out.

Densch[19] came to the conclusion that silica does not replace phosphoric acid but that soluble silicates induce better growth and greater intake of plant food from the soil. This was corroborated by Gile and Smith[20] who also found that silica greatly benefits the growth of plants receiving rock phosphate, presumably by increasing the quantity of phosphoric acid in solution. This benefit was not noticed when the more readily available acid phosphates were used.

Brenchley, Maskell and Warington[21] showed that under controlled conditions in water cultures, soluble silicate had little effect on the growth of barley if phosphorus was also present, but in the absence of the latter, significant increase in dry weight was induced by the silicate. There was no indication of partial replacement of phosphorus by silicon.

From a statistical analysis of the results on the Rothamsted continuous barley plots, Fisher[22] controverted the earlier conclusions of Hall and Morison (*loc. cit.*) and showed that the added silicate increased the total phosphoric acid content of the produce

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[10] Hall, A.D., and Morison, G. C. T., *Proc. Roy. Soc.*, 1906, **77B**, 455.

[11] Gregoire, A., *Bull. Soc. Chim. Belg.*, 1911, **25, ii**, 85.

[12] Jennings, D. S., *Soil Sci.*, 1919, **7**, 201.

[13] Shedd, O. M., *ibid.*, 1922, **14**, 233.

[14] Schollenberger, C. J., *ibid.*, 1922, **14**, 347.

[15] Lemmermann, O., and Wiessmann, H., *Z. Pflanz. Düng.*, 1922, **(A)1**, 185.

[16] Lemmermann, O., Wiessmann, H., and Sammett, K., *ibid.*, 1925, **(A) 4**, 265.

[17] Duchon, Fr., *ibid.*, 1925, **(A) 4**, 316.

[18] Nanji, D. R., and Shaw, W. S., *J. Soc. Chem. Ind.*, 1925, **44**, 1T.

[19] Densch, A., *Landw , Jahrb.*, 1924, **60**, 142.

[20] Gile, P. L., and Smith, J. G., *J. Agric. Res.*, 1925, **31**, 247.

[21] Brenchley, W. E., Maskell, E. J., and Warington, K., *Ann. App. Boil.*, 1927, **14**, 45.

[22] Fisher, R. A., *J. Agric. Sci.*, 1929, **19**, 132.

to an extent consistent with the increased yield. Others (Mange,[23] Seki[24]) have shown that addition of colloidal silica or silicates increases the efficiency of phosphates not only in phosphate deficient soils but also in soil or sand cultures containing useful quantities of that element. Arrhenius[25] found no evidence to show that addition of silicate to nutrient solutions in sand cultures reduced the phosphate requirements of plants. Jensen and Lesch[26] also obtained benefits from colloidal silica in sand cultures only when phosphorus was added in a difficultly soluble form or in mixed fertilisers which tended to render the phosphate insoluble.

A critical study of the literature would point to the following:—(1) Silicon may not be essential to plant life in the sense that phosphorus is, but it has nevertheless, a beneficial effect on plant growth and leads to increased crop yield. It enables the plant to withstand adverse climatic conditions and resist the attacks of fungi and insect pests. (2) Application of silicate facilitates better intake of phosphorus from either soils which are deficient in that element or mineral phosphates, which are not readily available. When phosphorus is present in a soluble or, at any rate, readily available form the assimilation of the two elements seems to proceed independently of each other. (3) Silicon does not appear to be capable of wholly substituting phosphorus in plant economy but its ability to do so at least partially is still an open question. (4) The seat of interaction between silicon and phosphorus is not well defined but is probably in the soil.

The original theory of Wolff and Kreuzhage (*loc. cit.*), is not tenable since all later work has shown that the extra phosphoric acid derived from the soil is itself sufficient to explain the greater yield without attributing to silica any specific action in economising the phosphoric acid present therein. The view that silica can replace phosphoric acid was held by Gregoire (*loc. cit.*) and first put forward by Lemmermann (who, however, modified it subsequently) and supported by Nanji and Shaw (*loc. cit.*) from analyses of various cereal straws. This again is hardly tenable, for if the function of the silica is to replace phosphoric acid within the plant, the larger crop due to fertilising with silicates would not contain any greater amount of phosphoric acid, but the general growth of the plant as represented by dry matter produced, or nitrogen assimilated, would be increased. In other words, the ratio of the phosphoric acid to total dry matter and nitrogen would be lowered in proportion to the increased growth. This is not, however, realised in practice as will be seen from the data of Hall and Morison (*loc. cit.*), Brenchley, Maskell and Warington (*loc. cit.*) and others which show that the ratio of phosphoric acid to nitrogen is generally raised by application of silicate. Again the observations of Densch (*loc. cit*), Gile and Smith (*loc. cit.*), Arrhenius (*loc. cit.*) and others lead to the conclusion that increased assimilation of silica does not enable the plant to get along with less phosphoric acid and that the beneficial effects of colloidal silica is observed only where phosphorus is present in insoluble or, at any rate, difficultly soluble forms.

That silicon acts as a plant stimulus facilitating better assimilation of phosphorus is the view held by Hall and Morison, who base their conclusion on the observation that the application of silicate lowers the proportion of phosphoric acid in the straw but raises it in the grain. Addition of silica to the ash naturally reduces the percentage of other constituents, while (as mentioned before) the increase in the proportion of phosphate in the dry weight of the crop is alone sufficient to account for the increased yield in grain and straw without postulating the aid of any stimulus to plant growth.

The nature of interaction between silicates and the soil and its bearing on the availability of phosphorus have not yet been adequately studied. The analytical data obtained by Lemmermann, Wiessmann and Sammett (*loc. cit.*) would suggest that the assimilation of phosphoric acid by the plant is increased in presence of soluble silica; that the latter exerts a solvent action on the phosphates present in the soil. Lemmermann's work consisted essentially of experiments in sand cultures and would therefore require repetition under field conditions before any definite conclusions can be drawn. Fisher's analysis (*loc. cit.*) of the results on Hoosfield barley plots, while

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[23] Mange, L., *Z. Pflanz. Düng.*, 1928, (B) **8**, 365.

[24] Seki, S., *C.A*, 1928, **22**, 2803.

[25] Arrhenius, O., *Z. Pflanz. Düng.*, 1930, (A) **16**, 94, 307.

[26] Jensen, W., and Lesch, W., *ibid.*, 1930, (A) **17**, 48.

showing that application of silicate increases the availability of phosphorus, still leaves the mechanism of phosphate dissolution unexplained. The experiments of Gile and Smith (*loc. cit.*) with rock phosphate and silica gel are not above criticism. Their pot-culture experiments have not been suitably replicated. Although a study of the solubility of phosphates in presence of silica gel is of much scientific interest, it should be admitted that it cannot reproduce the changes that attend the application of a silicate to the soil. There is indeed considerable evidence to show that the reactions taking place when a silicate is added to the soil may increase or decrease the efficiency of different phosphatic fertilisers and that these reactions vary in different soils. Even when a soluble phosphate is used, a part is fixed by the soil and we are ignorant as to how much of the fixed phosphoric acid is available and how much unavailable. Similar reactions have, in the writer's experience, been found to take place with regard to soluble silicates, so that the extent to which a soluble silicate aids phosphorus resorption is bound to vary with the type of soil under study.

It is possible that a part of the beneficial effect of silicate is due to purely physical causes. In this connection it should be noted that Lemmermann and Wiessmann (*loc. cit.*) obtained beneficial effects only with pure silica gel which is absorptively active, while kaolin, kieselguhr, permutites and other silicious materials gave no increase. Reifenberg[27] found that it is possible to peptise finely ground crude phosphate by colloidal silica and to obtain soluble crude phosphate-silica sols. He attributed the increased assimilation of phosphoric acid in presence of colloidal silica to the protective action of the latter which prevents the particles of crude phosphate from secondary aggregation and thus make them more easily available to the action of plant roots.

The practical significance of silicate fertilisation in field practice is still rather ill-defined. Thus, it is not possible to state whether the saving that might result in regard to phosphatic or potassic fertilisers by judicious use of silicates would be an economic proposition. Nicklas, Schropp and Hock[28] found that a "silico-super-phosphate" made by adding kieselguhr at one stage in the manufacture of super-phosphate showed some superiority over the ordinary commercial product. It is possible that some such process might ultimately offer a practical method of exploiting the beneficial effect of silicon in increasing the availability of soil phosphorus.

Nothing is known regarding the possible beneficial effects of silica on soil constituents other than phosphates. Whether the presence of a free supply of soluble silica enables the plant to repair any weak link in the chain of nutrition and get, as need be, more nitrogen, phosphorus or potash from the soil or whether its beneficial effect is solely confined to phosphoric acid is yet to be elucidated.

Although it is recognised that silicon toughens the tissues and makes the plant resistant to adverse climatic conditions, insect pests and fungus diseases, the mechanism of such action is still not properly understood. There is no doubt that this element which forms a high percentage of the mineral constituents of the plant fulfils certain important ecological functions. A fuller understanding of the rôle of silicon in plant growth and metabolism would be of considerable importance in agricultural and horticultural practice.

The transformations of silicon in the swamp soil and their bearing on the nutrition of the rice plant will be of special interest because, of all grain crops, none is so rich in silicon as that plant. The straw and the husk are exceptionally rich and, indeed, as suggested by Nanji and Shaw (*loc. cit.*) the swamp conditions may offer special facilities for the dissolution and intake of silica. No systematic work has, however, so far been carried out on this problem. It is well known that healthy development of the plant, satisfactory yield of paddy and rice of good quality can be obtained only when the swamp conditions are maintained and steady movement of water over the field is ensured: that even those varieties which are generally raised by dry cultivation give comparatively low yields and are of poor quality. The significance of this has so far remained obscure and indeed is rather puzzling when considering that (*a*) the actual water requirements of the rice plant are not higher than those of most other crops, and (*b*) its root system is essentially that of a land crop though with some adaptations for aquatic life. The

27 Reifenberg, A., *ibid.*, 1930, (A) **17**, 1.

28 Nicklas, H., Schropp, W., and Hock, A., *Arch. Pflanz.*, 1932, **9A**, 470.

available evidence would suggest that the swamp soil conditions increase the availability of certain nutrients which are not provided in sufficient quantities under conditions of dry cultivation. Further work is needed, however, to show whether the availability of silicon is increased under conditions of wet cultivation and whether the element thus assimilated plays any part, direct or indirect, in the nutrition of the rice plant. Researches on these and allied problems are already in progress in the laboratories of the Indian Institute of Science and it is hoped that, before long, it will be possible to throw some light on what has so far remained an enigma in agricultural practice.

## Obituary.

### Dewan Bahadur K. Rangachari, M.A., L.T. (1868-1934).

THE death of Dewan Bahadur K. Rangachari, M.A., L.T., on May 10, has removed from the Indian scientific world an eminent Botanist, a keen Ethnographer and a venerable personality.

He was born in September 1868 of very humble parentage. Left fatherless at an early age he had to fall on his own resourcefulness and pursued his studies with the help of fees earned by giving private tuition to young school children. He matriculated in 1885, passed his First Examination in Arts in 1888 from the Madras Christian College and took his B.A. degree in 1890 from the Pachiappa's College. With the help of a Government scholarship he studied in the Presidency College and took the degree of Master of Arts, taking a first class. He then qualified for the degree of Licentiate in Teaching and in 1895 started his career as Headmaster of the Municipal High School, Anantapur.

In March 1897 he entered Government service as Herbarium Keeper at the Government Museum at Madras. He worked at the Museum for five years until in July 1902 the teaching profession called him again and he was appointed Senior Assistant Professor in Presidency College. In 1904 he acted as Superintendent of Ethnography for a year. His touch with the Museum and Ethnography crystallised into the seven sumptuous volumes on "The Castes and Tribes of South India," which Mr. Edgar Thurston and he published in 1909. Mr. Thurston became a Companion of the Order of the Indian Empire and Mr. Rangachari's work was recognised by the Government of India with the title of Rai Bahadur in 1913.

From October 1909 began his two-fold connection with the Agricultural College and Research Institute, *viz.*, Instructional and Systematic Botany. His appointment as Lecturing Botanist gave him ample facilities for gathering data and perfecting a series of text-books on Indian Botany suited to various standards. He was one of the pioneers in this attempt at Indianising Botany and of vernacularising the same. His name is predominant in the world of instruction in Indian plant life. He was a Fellow of the Madras University and his wide experience was sought after by other universities and institutions in the organisation of their studies.

Mr. Rangachari was a great Systematic Botanist. As Herbarium Keeper at the Madras Museum, and later as Systematic Botanist in charge of the Coimbatore Herbarium he had a good share in the accrual of the collections enshrined in that Herbarium, which may now claim to be "one of the best in India". The rapid and repeated additions and the continuous consignments from it to Kew, resulted in Gamble's *Flora of the Madras Presidency*, a work which has so far run into 9 volumes. This Flora is in part a mute testimony to his colossal but unobtrusive energy. He helped a number of his colleagues, both European and Indian, in a characteristically quiet manner, often doing a considerable amount of selfless work for them. He studied the history of weeds of arable lands and wrote a useful handbook on the same. In addition to systematic work the Herbarium served as a clearing house for much botanical information of scientific and economic interest and many were the enquiries on which Mr. Rangachari threw helpful light.

He was President of the Section of Botany in the 4th Indian Science Congress at Bangalore in 1917 and delivered an address on "The Flora of the Tinnevelly Hills". He was one of the Foundation Members of the Indian Botanical Society and was its President for the year 1922.

Mr. Rangachari was a keen photographer

and a sound music critic. In the early days of the phonograph he was enthusiastic in taking successful records of the songs of the aboriginal tribes of the Nilgiris.

In June 1918 he was promoted to the Indian Agricultural Service, one of the earliest to get this recognition. He retired from service in September 1923 and was decorated Dewan Bahadur. Attuned to very active habits he continued to work with his accustomed vigour until he broke down under the strain into final rest. Simple in habits, warm in his emotions and encyclopædic in his equipment, his was a a full and abiding greatness.

G. N. R.

* * *

## V. Krishna Murti Iyer, G.M.V.C., I.V.S. (1885-1934).

WE regret to have to record the untimely death of M.R.Ry. V. Krishna Murti Iyer Avergal, G.M.V.C., I.V.S., on the 18th October 1934 at his residence in Parasuwakam. Born in the year 1885 he received the early education in the Kumbakonam College. He joined the Madras Veterinary College in 1906 and graduated from it with distinction in 1909. After a brief service in the Civil Veterinary Department he was appointed lecturer in the Madras Veterinary College in 1910. By dint of hard work and high ability he rose in service till he was promoted to the Indian Veterinary Service in 1922.

He worked in several Indian laboratories and did much important work on nasal granuloma and lymphangities of cattle. That he should have passed away so early in life is a serious loss not only to his relations and friends, of whom there are many, but also to the cause of Veterinary Science and Veterinary service. For had he lived longer it is possible that some, if not all, of the results of his investigational experiments would have seen the light of day. Being the fruits of long years of laborious work and study and vast experience they would have been of undoubted value. If he had been spared some time longer it is also possible that with his vast influence with the Government he might have successfully championed the cause of the subordinate service.

The Madras Veterinary College has lost in his death a most energetic, a well-informed and impressive professor who cannot be easily replaced.

S. D. ACHAR.

* * *

## Sir Arthur Schuster (1851-1934).

WE regret to record the death of Sir Arthur Schuster, F.R.S., the eminent physicist, on Sunday, October 14, at his home. Born on 12th September 1851, he was appointed Professor of Applied Mathematics in 1881 and was subsequently appointed Langwerthy Professor of Physics at Owen's College, Manchester. He took an active part in four eclipse expeditions, the first one to Siam when he was only twenty-four years of age and the others in Colorado, Egypt and West Indies. After his retirement from the Professorship in 1907, he took a keen interest in the establishment of co-operation in Science and assumed an active part in the International Association of Academies and the International Research Council founded after the Great War.

## Letters to the Editor.

### Ground-absorption of Wireless Waves and the Electrical Conductivity of the Earth.

ACCORDING to Van der Pol,[1] Sommerfeld's value of "flat-ground" attenuation can be obtained from the formula:

$$\phi(\rho) = \frac{2+0\cdot3\rho}{2+\rho+0\cdot6\rho^2}$$

where $\rho$ is Sommerfeld's "numerical distance". If $d$ is the actual distance in kilometres from the transmitter ($d >> \lambda$), $\sigma$ the electrical conductivity of the ground in e.m.u. and $\lambda$ the wave-length in km., it can be shown that the numerical distance is given by

$$\rho = \frac{\pi 10^{-15}}{6\sigma}\frac{d}{\lambda^2}$$

provided wave-length is not too short ($\lambda >$ 200 m.) and the ground conductivity not too poor.

The formula is valid within a few per cent. for values of $\rho$ up to 50.

By applying this formula to the radio-field-strength measurements round the various transmitting stations, we have obtained the following values of the effective conductivity of the earth for some of the *metropolitan cities* in a few directions:

| Cities | Directions | Range | $\sigma$ in e.m.u. | Remarks |
|---|---|---|---|---|
| Calcutta ($\lambda = 370$ m.) | North-East<br>South | 8 – 18 km.<br>6 – 10 km. | $2\cdot60 \times 10^{-14}$<br>$6\cdot00 \times 10^{-14}$ | From Rakshit's field-strength data.[2] |
| London ($\lambda = 360$ m.) | North<br>South | 0 – 20 km.<br>0 – 20 km. | $1\cdot80 \times 10^{-14}$<br>$1\cdot80 \times 10^{-14}$ | From Barfield and Munro's data.[3] |
| New York ($\lambda = 492$ m.) | A<br>B<br>C (hilly) | 3 – 6 km.<br>8 – 10 km.<br>1 – 2 km. | $2\cdot90 \times 10^{-14}$<br>$8\cdot00 \times 10^{-14}$<br>$0\cdot80 \times 10^{-14}$ | From Bown and Gillett's field-strength data.[4] |
| Washington ($\lambda = 469$ m.) | A<br>B | 0 – 20 km.<br>0 – 20 km. | $2\cdot80 \times 10^{-14}$<br>$1\cdot65 \times 10^{-14}$ | Ditto. |

In computing the above values of $\sigma$, we take the attenuation factor equal to $\frac{E.d}{E_o d_o}$ where $E_o$ is the value of the field-strength at a distance $d_o$ which is so near the transmitter that there is no perceptible ground absorption and E is the value of field strength at any longer distance $d$. This ratio plotted against distance $d$ in a given direction gives the attenuation curve for that direction. Taking two points on this curve $\sigma$ is calculated. It is expected that this *calculated* value of the earth-conductivity over metropolitan areas will be smaller than the *actual* value of the same, for attenuation of wireless waves in big cities is usually larger than in open countries due to energy-losses in large structures, buildings, etc.

For *open countries*, the value of land conductivity is of the order of $10^{-13}$ e.m.u. (see Pol, T. L. Eckersley, Dellinger and Corbeiller[5]).

It is curious that the open-country values of $\sigma$ obtained from field-strength data are decidedly larger than those obtained by direct experiments with soil which agree on the other hand with the city-values of $\sigma$ given in the table. For Daventry and Cambridge specimens of soil, for example, Ratcliffe and White's[6] values of $\sigma$ under normal moisture conditions are $4\cdot5 \times 10^{-14}$ and $2\cdot6 \times 10^{-14}$ e.m u. respectively ($\lambda = 360$ m.). Our own measurements also by the method of Ratcliffe and White with specimens of Dacca soil yielded a value equal to $2\cdot2\times10^{-14}$ e.m.u. for $\lambda = 181\cdot5$ m. The percentage of moisture to dry soil by weight is about 20 on the average. "For moderately damp land," Strutt's[7] value of $\sigma$ is $5 \times 10^{-14}$ e.m.u. (frequency = $2 \times 10^6$ cycles/sec.). Recent measurements of Smith-Rose[8] give

[1] Van der Pol, *Exp. Wireless & W.E.*, Oct. 1930.
[2] H. Rakshit, *Phil. Mag.*, Jan. 1931.
[3] Barfield and Munro, *Exp. Wireless & W.E.*, 1928–29.
[4] Bown and Gillett, *Proc. I.R.E.*, Aug. 1924.
[5] Pol, Eckersley, Dellinger and Corbeiller, *Proc. I.R.E.*, July 1933.
[6] Ratcliffe and White, *Phil Mag.*, Oct. 1930.
[7] Strutt, *Exp. Wireless & W.E.*, Jan. 1931.
[8] Smith-Rose, *Proc. Roy. Soc.* (A), May 1933.

higher values of $\sigma$ which, however, agree with the average open-country value obtained from field-strength data. For example, $\sigma = 1 \times 10^{-13}$ e.m.u. when the moisture content of the Teddington soil is 20 per cent.

Emphasis should not, however, be laid on these comparisons. There are uncertainties in the soil conditions, *viz.*, nature of the ingredients, moisture-content, vegetation on the surface, etc. Besides, it should be remembered that Sommerfeld's formula is applicable to vertical dipole aerials. The application of this formula to the field-strength data obtained with a transmitting aerial which gives directional effect cannot therefore be expected to give a correct estimate of $\sigma$. Again, the length and the lay-out of the aerial may at times considerably affect the attenuation of wireless waves from which the effective conductivity of the earth is calculated. If the ærial be an inclined multi-pole ærial, a part of the waves may be concentrated upwards. The old transmitting aerial of our wireless laboratory may be mentioned in this connection. The lead-in wire from the horizontal part of the aerial wire was very much inclined to the vertical and the total length from the insulated end of the aerial to the earth-point was about a third of the radiated wave-length. The voltage antinode was at the insulated end and a node somewhere down on the lead-in wire. Electrical oscillations could evidently take place between one part of the aerial to another in a slanting direction causing thereby a concentration of waves upwards. As a consequence, we[9] obtained a high value of attenuation in the city of Dacca.

Attention should therefore be directed to the transmitting aerial in order to get a correct estimate of $\sigma$ by the application of Sommerfeld's theory of ground absorption to radio-field-strength data.

S. R. KHASTGIR.

Wireless Laboratory,
Dacca University,
*October 18, 1934.*

## The Arc Spectrum of Selenium.

IN a recent paper,* the authors have published a set of energy levels newly found out in SeI, in the course of an extensive investigation on the spectrum of Selenium. Some of these levels were arbitrarily designated by the symbols *a*, *b*, etc., *h*. In the light of the (unpublished) results obtained by one of the writers (S.G.K.)† on the arc spectrum of Tellurium, it is possible, by a comparison of these two spectra, to make the following definite assignment of four of the above levels of SeI, thus:

| Level Designation | | Level Value | |
|---|---|---|---|
| Old | New | SeI | TeI |
| *f* | $5s(^1D)\ ^3D_2$ | 13379 | 14071 |
| *g* | $^3D_1$ | 13357 | 13923 |
| *h* | $^3D_3$ | 13316 | 13840 |
| *e* | $^1D_2$ | 15183 | 15553 |

The corresponding levels identified in TeI are also included for comparison in the above table. It will be seen that both in SeI and TeI, the $^3D$ term is partially inverted although in SI‡ it is normal and further the $^1D$ term is deeper than the $^3D$, of this configuration.

K. R. RAO.
S. G. KRISHNAMURTY.

Andhra University,
Waltair,
*October 28, 1934.*

## An X-Ray Investigation of the Crystals of M-Azotoluene.

THE crystals of m-azotoluene have been studied by the rotation method and the following values have been found for the dimensions of the unit cell:—

$a = 11{\cdot}88$ Å, $b = 13{\cdot}75$ Å, $c = 7{\cdot}52$ Å.

Thus $a : b : c = 0{\cdot}8581 : 1 : 0{\cdot}5469$.

This is in good agreement with the ratio determined by the crystallographers ($a : b : c = 0{\cdot}8556 : 1 : 0{\cdot}5438$.§ The crystals belong to the rhombic bipyramidal class.$ The observed halvings show that (hol) planes are

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[9] Chowdhuri and Khastgir, *Ind. Jour. Phys.*, **8**, Part V.

* *Proc. Roy. Soc.*, (A), 1934, **145**, 695.

† *Curr. Sci.*, 1933, **2**, 210; see also Bartelt, *Zeits. f. Phys.*, 1934, **88**, 522.

‡ Frerichs, *Zeits. f. Phys.*, 1933, **80**, 156.

§ Gröth, Vol. **5**, p. 66.

$ Gröth, *loc. cit.*

halved when $h$ is odd and (hko) are halved when $k$ is odd, and that the crystals belong to the space group $Q_h^{11}$¶. The number of asymmetric molecules required by the space group is eight while that calculated from the above dimensions of the unit cell and the density of the crystals, which was found to be 1·05, is four. This indicates that the molecules possess an element of symmetry which may be a centre of symmetry, or a dyad axis perpendicular to (001) or a plane parallel to (100). Further work on the complete elucidation of the structure is being undertaken.

M. PRASAD.
P. H. DALAL.

Chemical Laboratories,
Royal Institute of Science,
Bombay,
*October 1934.*

¶ *Cf.* Astbury and Yardley, *Phil. Trans.*, 1924, **224**, 221.

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### Vitamin C in Indian Food-Stuffs.

WE have lately been engaged in a systematic investigation of the ascorbic acid contents of various Indian food-stuffs, especially fruits, by the technique of Harris and Ray,[1] slightly modified by the introduction of glacial acetic acid to the solution of 2:6-dichlorophenol-indophenol before titration against the trichloroacetic acid extracts of the food-stuffs.[2] Figures are given below in mg. ascorbic acid per gramme of the fresh edible material. More than 30 food-stuffs have thus been studied, and, of these, the guava, the mango (*langra* variety) and the lichi appear to be the richest sources, containing 1·04, 0·69 and 0·48 mg. ascorbic acid respectively. The different varieties of the mango, *deshi*, *fozli* and *langra*, differ markedly in their ascorbic acid contents, containing 0·22, 0·1 and 0·34 mg. ascorbic acid (see also Guha and Chakravorty[3]).

The ascorbic acid content of *kancha-mung* (*Phaseolus mungo*) is increased 7·8 times by germination, calculated on the basis of dry weight. Parallel estimations by biological and chemical methods indicate that trichloroacetic acid does not completely extract the Vitamin C of germinated *mung* (see also Johnson[4]).

The mango (*deshi* variety, obtained from a particular tree) has been found to contain 0·1, 0·05 and 0·2 mg. ascorbic acid at the bud, green and ripe stages respectively. The values for the guava obtained from one tree at the bud and green stages of development are 0·41 and 0·28 respectively. It would seem, therefore, that the process of development of these fruits, unlike that of germination of the seed, involves a progressive reduction in the ascorbic acid content.

B. C. GUHA.
A. R. GHOSH.

Biochemical Laboratory,
Bengal Chemical &
Pharmaceutical Works, Ltd.,
Calcutta,
*November 3, 1934.*

1 Harris and Ray, *Biochem. J.*, 1933, **27**, 303.

2 Guha and Ghosh, *Curr. Sci.*, 1934, **2**, 390.

3 Guha and Chakravorty, *Ind. J. Med. Res.*, 1933, **20**, 1045.

4 Johnson, *Biochem. J.*, 1933, **27**, 1942.

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### A Note on the Changes in the Physical and Chemical Characteristics of the Blood Sera of Opium Addicts.

INITIATION into the opium habit is generally found to take place with a view to relieve some mental or physical pains and also certain other ailments such as diarrhœa, etc. In such cases of physical troubles people really find some relief, specially in the beginning, but this gradually develops into a habit which it is difficult to get rid of. The symptoms attending the withdrawal of the habit are extremely painful since it sometimes ends in complete breakdown or even collapse on the part of the addict. Pierce and Plant's observations[1] on the dilution of blood on addiction as well as Barbour, Hunter and Richey's corroborating observations[2] from a study of the specific gravity of the whole blood serve as clues to some real changes in the blood of the addicts. Henderson and Haggard's[3] observation on the increase of carbon dioxide tension is also very interesting from this point of view. The disturbance in the water-balance of the system consequent upon the withdrawal of the habit has been regarded by Rowntree as a condition somewhat allied to water poisoning. From these

1 *J. Pharmacol. and Exp. Therap.*, 1928, **33**, 359.

2 *Ibid.*, 1929, **36**, 251.

3 *J. Biol. Chem.*, 1916, **33**, 333.

considerations the present work was undertaken with a view to find out any changes in physico-chemical properties or in the protein fraction of the blood sera of the opium addicts as commonly found in India, since physico-chemical properties and proteins are known to be responsible for many apparent changes of the blood.

From a study of 25 opium addicts the following observations were made. The pH in all the cases is found to be near the lower limit of the normal Indian subjects while the buffer action seems to be considerably lowered. These facts are most probably the necessary outcome of the increased carbon dioxide tension and diminished alkaline reserve as observed by various workers (Henderson and Haggard,[4] Cobet,[5] and Barbour, Hunter and Richey[6]). The diminished viscosity and an increased surface tension of the blood sera point to an increase in the fluid content while the slight increase in viscosity of the whole blood which corroborates similar observations of Sollier[7] may be due to a change in the fluid content of the red cells. As to the protein changes in the blood sera, the albumin fraction which has been found to increase above its normal value is probably responsible for the disturbance in the water balance which was up till now supposed to be due to a variety of causes, like disturbances in fat metabolism, etc. Another important observation is the increase in the euglobulin content of the sera which probably accounts for the nervous symptoms owing to a drainage of lecithin from the nerve cells to form an increased amount of euglobulin as observed in these cases. The pseudoglobulin and the total proteins have been found to decrease below their normal values, the former to a greater extent than the latter. These protein changes appear to be of considerable interest from the point of view of the reshuffling of the lecithin distribution. The field work done in this direction corroborates these observations inasmuch as diets rich in phosphates are found to annul the physical and mental degenerations to a very great extent.

Further work along this direction is in progress specially with respect to the fat metabolism in the system of the addicts, since fat is known to have important effect upon the water retention in the system and being itself the glyceryl ester of fatty acids is closely related to the glycerophosphates on whose metabolism it exerts an influence. These findings may possibly have some important bearing upon the pathology and treatment of opium habitues.

R. N. CHOPRA.
S. N. MUKHERJI.
Department of Pharmacology,
School of Tropical Medicine,
Calcutta.
*October 19, 1934.*

[4] *Loc. cit.*

[5] *Biochem. J.*, 1923, **2**, 137, 67.

[6] *Loc. cit.*

[7] *J. d. med. d.*, Paris, **30**, 875.

## Apple Rot caused by *Fusarium moniliforme* Sheldon.

THE writer collected a number of *Fusaria* growing saprophytically. Amongst these *F. viride* (Lechm.) Wr. re-named as *F. solani* var. *medium* Wr. proved to be a new wound parasite of potato tubers.[1] Bacteria-free, single-spore cultures of another species, *viz.*, *F. moniliforme* Sheldon, kindly identified by Dr. Wollenweber, were inoculated into both the "hill" and the "Kashmir" varieties of apples. The "Kashmir" apple differs from the other in being elongated in the vertical or blossom axis, sweeter, less acidic and brighter in colour. Inoculations were made by the method devised by Granger and Horne[2] and used by Mitter and Tandon,[3] with a minor change in the substitution of a straight needle in place of the usual hooked one. The inoculated apples as well as the controls were left undisturbed for 35 days at room temperature (19·5°–22·8°C.). Both the varieties of apples were infected (Fig. 1) and the average damage done was 22·01%. *F. moniliforme* was re-isolated in a pure form from the diseased parts of each apple while the controls remained healthy. As far as the author is able to ascertain there has been no previous record of *F. moniliforme* Sheldon as showing any parasitic activity on apples. *F. camptoceras*, *F. semitectum*, *F. semitectum* var. *majus* and *F. diversisporum*

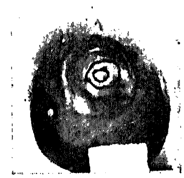

**Fig. 1.**

[1] Mitra, Anil, *Nature*, 1934, **133**, 67.

[2] Granger and Horne, *Ann. Bot.*, 1924, **38**, 212.

[3] Mitter and Tandon, *Jour. Ind. Bot. Soc.*, 1929, **8**, 212.

failed to infect the apples. It is therefore seen that at least some of the *Fusaria* growing saprophytically in nature are not obligate saprophytes and if they cannot infect healthy fruits and tubers they may still cause a rot by getting into their tissues through accidental wounds.

ANIL MITRA.

Department of Botany
University of Allahabad,
*November 1, 1934.*

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### Dichotomous Branching in the Leaves of *Pleopeltis simplex* Sw.

THE normal frond in *Pleopeltis simplex* Sw. is simple, lanceolate, entire. In some specimens of the species collected by Prof. Kashyap in the Jumna Valley* in Tehri Garhwal in July, 1932, fully developed fertile leaves bifurcating once or twice have been found along with the usual simple ones on the same plant. Such fronds are of special interest in throwing some light on the systematic position of the genus. The dichotomous branching is found developed in various stages in these fronds. In some the tip is merely notched, in others there are two small acute lobes, but in several cases there are two well-developed large fertile lobes both of which may again be forked.

The genus *Pleopeltis* formed a part of the comprehensive genus *Polypodium* according to the early writers, Hooker,[1] Christ[2] and Diels.[3] After the separation of *Dipteris* by Seward and Dale[4] as the sole surviving representative of the family Dipteridaceæ which family flourished in the Mesozoic, Bower[5] pointed out that many Polypodioid ferns will have to be regarded as derivatives of the Dipteridaceæ. *Phlebodium aureum* was referred to as a probable case. Later on investigations on some species of *Pleopeltis* by Goebel,[6] disclosed that the genus seemed to show some relationships with the Dipteridaceæ. The general habit, the area of distribution of this genus which is richly represented in the Malayan region to which *Dipteris* is restricted, the reticulate venation in the lamina forming irregular areoles with free included veinlets, the naked circular or oval sori occurring within the meshes were pointed out as features probably indicating relationship in this direction. The 'diplodesmic state' of venation which is a characteristic feature of the advanced members (Dipteroids) of a series begun in Dipteridaceæ is also known in one species of *Pleopeltis*, *P. Shraderi.*[7]

A characteristic feature of *Dipteris* is the basic dichotomous venation of the frond. The principal veins divide dichotomously and the secondary ones emerging from them at a wide angle branch and anastomose forming irregular areoles with free included veinlets. In *Dipteris lobbiana* the fronds are repeatedly dichotomously divided ending in long linear lobes with a central midrib and a row of naked circular sori on either side. This represents the simplest state of affairs in the genus. In other species like *D. conjugata* greater complexity is introduced in the webbing of the lamina and the simultaneous multiplicity of the sori which, however, retain their individuality, but the same dichotomous plan is manifest in the venation. In the Mesozoic fossils referred to the Dipteridaceæ the form of the lamina again is characteristically on the same lines. In *Hausmannia dichotoma*[8,4] discovered by Dr. Marcus Gunn in the upper jurassic rocks on the north-east coast of Scotland and also reported in the beds of approximately the same age at Quedlinberg the leaf is very similar to that of *Dipteris lobbiana*. It is, therefore, evident that the form of the lamina based on the dichotomous divisions of the primary veins is a very consistent feature of the Dipteridaceæ both living and fossil. This fact becomes still more significant when we find that in some of the modern derivatives of the Dipteridaceæ which show on the whole a distinct advance we find the repetition of this ancestral character. The erect leaves of Platycerium exhibit this in a remarkable degree. In *Cheiropleuria*, besides the bifurcating leaves simple ones are also commonly found.

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* The plants were found growing on the road-side near the wooden bridge on the Jumna about 12 miles below Jumnotri and about 2 miles below the village Ráná.

[1] Hooker, Sir W. J., *Synopsis Filicum*, 1874.

[2] Christ, H., *Die Farnkrauter Der Erde.*, 1897.

[3] Diels, In *Engler & Prantl*, 1902.

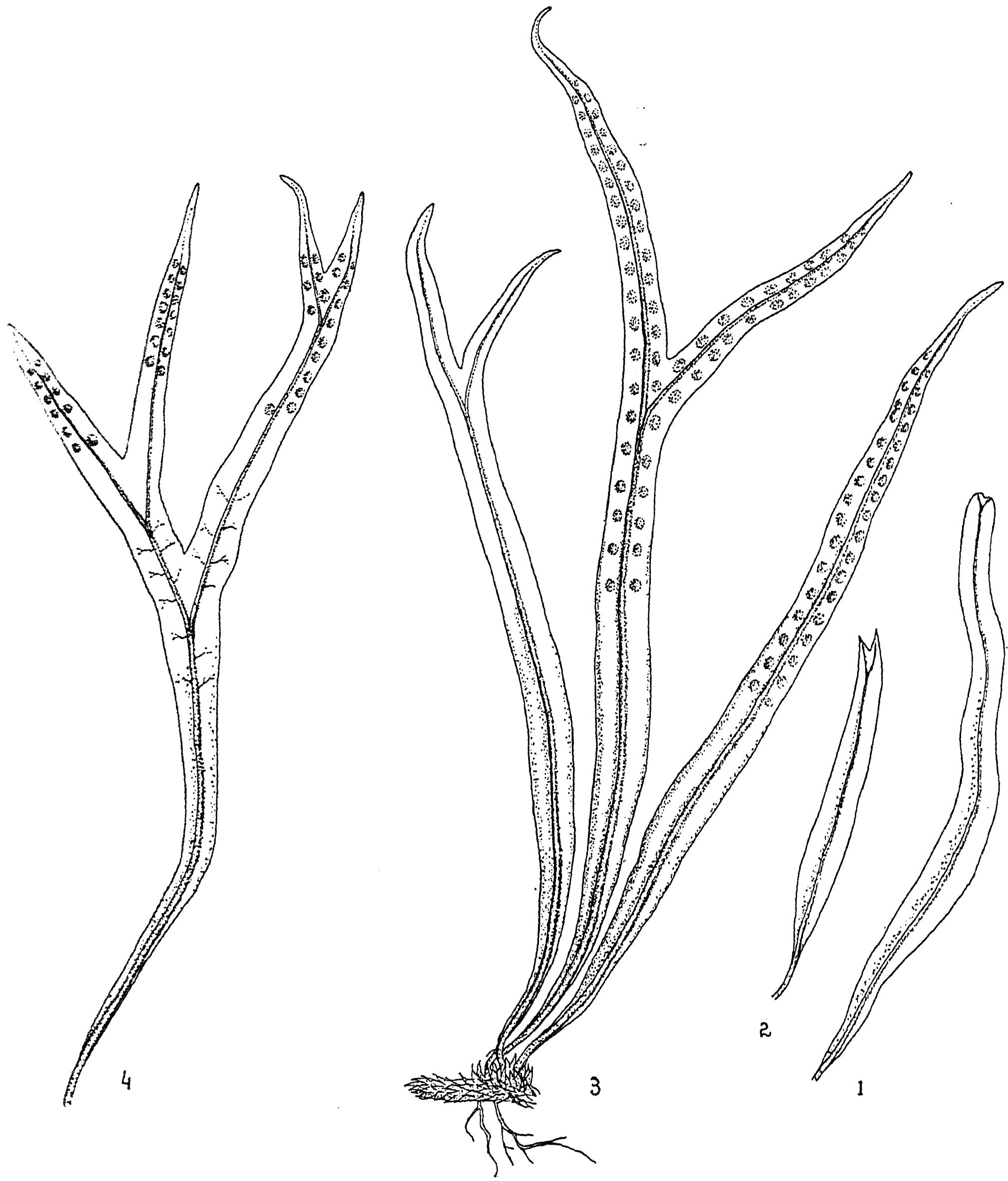
[4] Seward, A. C. & Dale, E., "On the Structure and Affinities of Dipteris, with Notes on the Geological History of the Dipteridinæ," *Phil. Trans.*, 1901, **194**, 487.

[5] Bower, F. O., *Studies Ann. Bot.*, 1917.

[6] Goebel, quoted by Bower, F. O., *Filicales*, 1928, **3**, 224.

[7] Do. *Ibid.*, 226.

[8] Seward, *Fossil Plants*, 1910, **2**, 390-392.




*Pleopeltis simplex* Sw.

**1.** A frond showing a notch at the apex. **2.** A frond showing two teeth at the apex. **3.** A plant bearing a normal frond with two others dichotomously branched. **4.** A frond showing double dichotomy.

The abnormal leaves of *Pleopeltis simplex* in the light of the above are of special morphological interest. The striking resemblance in form with the leaves of *Dipteris lobbiana*, particularly the young ones and the Mesozoic *Hausmannia dichotoma*, is evident. The ultimate linear lobes in *Pleopeltis simplex* bear a single row of circular[9] naked sori on

[9] The peltate stalked scales that cover the sori in some species of *Pleopeltis* (*P. macrosphaera*, *P. simplex*, etc.) are of entirely different nature from the indusial coverings. Developmental evidence as well as comparison with other related forms reveal their morphological nature as ordinary hairs interspersed among the sporangia that have become flattened at the upper ends resulting in the formation of peltate scales (Goebel, quoted by Bower, *Filicales*, **3**, 225).

each side of the midrib as in the above-mentioned species. The primary veins divide dichotomously giving off secondary ones at a wide angle which branch and anastomose forming irregular areoles with blindly ending veinlets as in Dipteridaceæ both living and fossil. The occurrence of dichotomous fronds in the present case which probably represents a reversion to the ancestral character is a further support in favour of the genus being placed in the Dipteroids as one of the modern representative of Dipteridaceæ that have advanced to the level of the Mixtæ.

S. R. KASHYAP.
P. N. MEHRA.

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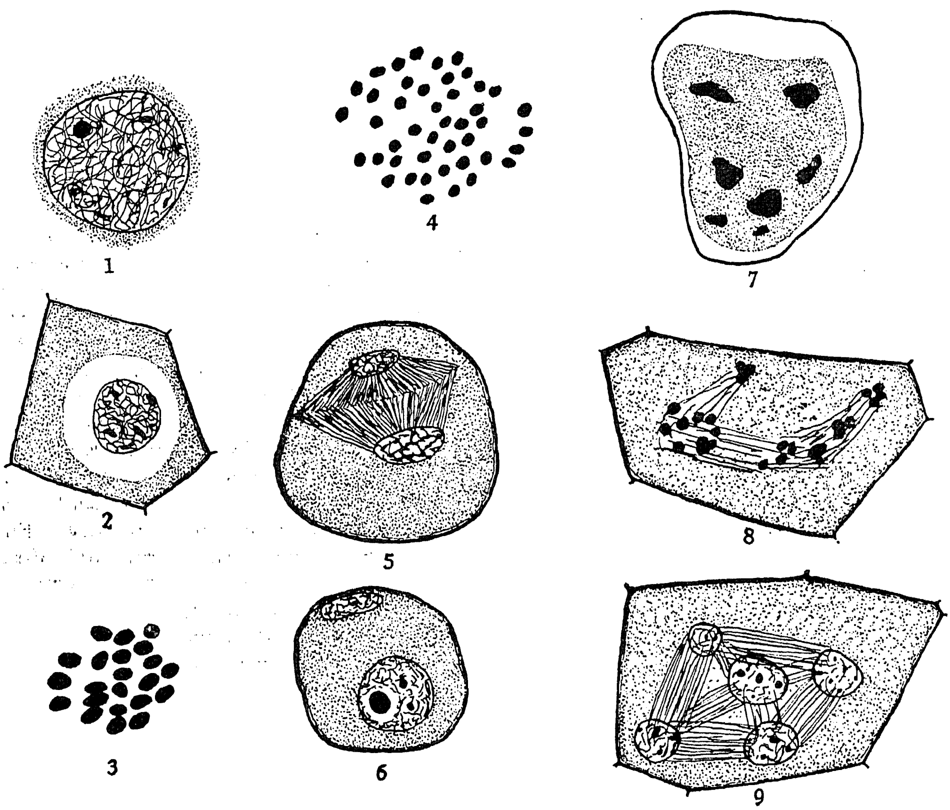
**Pollen Sterility in *Zeuxine sulcata* (Lindley).**

IN *Zeuxine sulcata*, some of the microspore mother cells go through the first meiotic threads (Fig. 1) and later on the cytoplasm withdraws from the nuclear membrane (Fig. 2).

In the cells that show normal division, 22 bivalent chromosomes can be counted on the heterotypic metaphase plate (Fig. 3). During the very early anaphase when the chromosomes are being just pulled apart, occasionally the univalent chromosomes lie well spread out on the spindle area, so that in favourable preparations 44 univalents can be clearly seen (Fig. 4), each univalent chromosome being almost half in size of a bivalent. So the 22 bivalents seen on the heterotypic metaphase plate can be safely taken as the haploid number for the plant. Moreover, the same number of bivalents have been counted during the heterotypic division of the megaspore mother cell also.

The second meiotic division seems to be




**Figs. 1 to 9.**

division normally, while others, in the same pollinium, show signs of degeneration even from an early stage. In such cells the nuclei show a dense reticulum of thin chromatin suppressed; hence "diads" of microspores are formed. The nucleus of the microspore on dividing (Fig. 5) gives rise to a vegetative nucleus and a generative nucleus (Fig. 6)

but these spores are not functional since they decay gradually (Fig. 7).

In some pollinia abnormal spindles (Fig. 8) are formed in the mother cells during the heterotypic division. This results in the formation of non-functional supernumerary nuclei (Fig. 9). Finally the whole tissue of the pollinium is attacked by a fungus and intracellular digestion occurs.

The meiotic irregularities in the microspore mother cells and the final pollen sterility is in correlation with the apomictic development of embryos reported before* in the same plant.

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*October 22, 1934.*

* *Curr. Sci.*, 1932, **1**, 102, also Errata Index to Vol. 1, page xiii.

## A Peculiar Cotton Plant.

THE number of seeds in the loculi of cotton is a character of some taxonomic importance. Although Watt[1] (1907) is not prepared to attach much importance to this character, Lewton[2] (quoted by Harland, 1932) considers this as a character of basic importance and has transferred *G. drynarioides*, Seem, to a new genus Kokia—because these plants have axillary flowers and the loculi are one-seeded. In view of the importance of the number of seeds per loculus, the following description of a plant which was met with in a field of Mollisoni cotton (*G. Indicum*, var. *Mollisoni*, Gammie) near Chak Jhumera in the Lyallpur district of the Punjab would be very interesting.

Stem, weak, about 3½ feet high, but due to weakness was bending down. Branches long and trailing giving the plant a bushy appearance. Leaves deeply incised and very much reduced in size. Buds were very profuse, corolla colour yellow and a high shedding of bolls. The few bolls which were present were very small in size and invariably 3-locked. Each lock had six or seven ovules, but *only one* mature seed resting on the base of the lock. When the bolls were matured, only one sound seed was found in each loculus and the rest of the ovules were very much shrivelled up. The seeds were downy and had very sparse short lint hairs.

Four seeds were collected from this plant. One was found to be faulty, but the other three germinated very well. I have, however, not been able to rear plants and all the seedlings died one after the other. But so far as I could study death was not caused by the operation of genetic lethal factors; but was only a matter of accident.

In all probability the above plant was a mutant and I am putting it on record for the information of other research workers.

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*October 20, 1934.*

[1] Watt, Sir George, *The Wild and Cultivated Cotton Plants of the World*, 1907, Longmans, Green & Co., London.

[2] Lewton, F. L., Quoted by Harland, *Bibliographis Genetica*, 1932, **9**.

## On the Trematode Infections in Certain Indian Fishes.

LONG ago, in 1910, Captain Parker obtained some immature stages of a fluke from "Mahaseer", *Barbus tor* (Ham. Buch.) which was first named *Isoparorchis trisimilitubis* and then later on proved to be a synonym of *I. hypselobagri* (Billet, 1898) by Ejsmont. In 1913 Southwell[1] obtained some specimens of this fluke from the gas-bladder of a common siluroid fish, *Wallago attu* (Bl. Schn.). In the same year he also discovered some other Trematodes, such as *Anaporrhutum albidum*, *A. largum* Lühe, *A. richiardii* Lopez from some Elasmobranch fishes, *viz.*, *Chiloscyllium indicum* (Gmel.), *Stegostoma tigrinum* (Gmel.) and *Aëtobatis narinari* (Euphrasen) respectively. Furthermore, Southwell and Prashad[2] described some five specimens of flukes (which they simply referred to as Trematode sp.) obtained from certain food-fishes, *viz.*, *Ophiocephalus marulius* (Ham. Buch.), *O. striatus* (Bloch.), *Trichogaster fasciatus* (Bl. Schn.) and *Saccobranchus fossilis* (Bloch.). In 1921 Bhalerao and Woodland rediscovered some specimens of *I. hypselobagri* (Billet, 1898) from *Wallago attu* from the same region as Southwell did. Chandler[3] in 1926, however, recovered some large flukes belonging to the last-named species from the stools of a human patient

[1] Southwell, *Rec. Ind. Mus.*, 1913, No. 9.

[2] Southwell and Prashad, *Ibid.*, 1918, No. 15.

[3] Chandler, *Ind. Jour. Med. Res.*, 1926, **14**.

in Calcutta, which were identified as such by Bhalerao.[4] This latter author also obtained some specimens of this fluke from *Ophiocephalus striatus* at Nagpur (C.P.) in 1928, and Faust[5] also recorded the presence of this parasite in man in China in 1929.

In 1927, Verma[6] discovered some specimens of *Opisthorchis pedicellata*, sp. nov. from the gall-bladder of two siluroid fishes, *Rita rita* (=*Rita buchanani*, Bleeker) and *Bagarius yarrellii* (Ham. Buch.). Thapar[7] wrote an account of a Trematode which he named *Gomtia piscicola* obtained from a siluroid fish (name not given). In 1933 several new and interesting species of Trematode parasites of fishes were described independently by Srivastava,[8] Chatterji[9] and Harshey.[10] The first of these authors dealt with *Ophiocorchis lobatum*, n.gen., n.sp. and *O. singularis*, n.sp. obtained respectively from the stomach and the intestinal cæca of *Ophiocephalus striatus*, and also *Progonus piscicola*, n.sp. and *P. ovocaudatum*, n. sp. found respectively within the stomach and the intestine of *Ophiocephalus punctatus* (Bloch.), whereas the second author chiefly confined himself with the account of *Astriotrema spinosa*, n.sp., *Ganada clariæ*, n. gen., n. sp., and *Masenia collata*, n. gen., n. sp. obtained from the post-stomach and the intestinal regions of *Clarias batrachus* (Linn.). Harshey described some distomes belonging to a new species, *Opegaster anguillii*, n. sp. obtained from the intestine of the common fresh-water Indian eel, *Anguilla bengalensis* (Gray and Hardw.).

Lately during the course of our general work on fishes here in Hyderabad we also wrote a note[11] on certain helminth parasites obtained from some fishes, and amongst these we recorded the occurrence of *Isoparorchis hypselobagri* (Billet, 1898) in a number of food-fishes, *e.g.*, in four species of *Ophiocephalus*, *Gobius giuris* (Ham. Buch.), *Mastacembelus armatus* (Lacép.) and *Wallago attu*; and as a result of our further investigations we now wish to add another fish to the list, *viz.*, the "Feather-back", *Notopterus notopterus* (Pall.) which has fallen a victim to this last-named parasite as well. In all five flukes (*I. hypselobagri*, Billet, 1898) have been obtained from this fish—two from the substance of the liver and three from the mesentery, and on being flattened they measured from 9·5 mm. (l) × 3·9 mm. (b) to 18 mm. (l) × 7 mm. (b), where l=length and (b)=breadth.

It must be pointed out that in certain cases the infection is quite or fairly common as with *Ganada clariæ* and *Masenia collata*, or less common or even rare in certain other cases, as for example, with Ophiocorchis and Progonus, or it is quite possible that 50 per cent. of a certain group of fishes may be infected with the parasites, as, for instance, by *Opisthorchis pedicellata*. Since these Trematode parasites have such a wide range of distribution amongst their piscine hosts (most of them being food-fishes, so far as they have been investigated for the present and at the same time being seemingly transferable from one group to the other owing to their predaceous habits) and have also been detected in the human stools, it seems hardly necessary to emphasise that great care should be taken while selecting an edible fish so as to avoid all probable and possible infections (*cf.* Bhalerao).

In conclusion we take this opportunity of expressing our great indebtedness to the Director as well as to Mr. G. D. Bhalerao, M.Sc., of the Imperial Institute of Veterinary Research, Muktesar (U.P.), for the courtesy of identifying the helminth parasites and for supplying us some most valuable information on certian helminthological subjects which do not constitute our main line of work, but all this is a mere side-track in our investigations, and we venture to publish this note embodying an outline review of the Trematode parasites of certain Indian fishes with the hope of getting some further useful suggestions from others who are actually engaged in this particular direction.

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B. K. DAS.

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*October 1934.*

[4] Bhalerao, *Ind. Jour. Vet. Sci. & Ani. Husband.*, 1932, **2**, Part 4.

[5] Faust, *Human Helminthology*, Philadelphia, 1929, 22.

[6] Verma, *Rec. Ind. Mus.*, 1927, **2**, 29.

[7] Thapar, *Ann. Parasitol.*, 1930, 7.

[8] Srivastava, *Bull. Acad. Sci. U.P.* 1933, **3**, No. 1.

[9] Chatterji, *Bull. Acad. Sci. U. P.*, 1933, **3**, No. 1.

[10] Harshey, *Bull. Acad. Sci. U. P.*, 1933, **3**, No. 2.

[11] Das and Rahimullah, *Curr. Sci.*, 1933, **1**, No. 9.

### Dispersal of Gall Mites by Gall Midges.

WHILE investigating the rôles of the mite *Eriophyes cheriani* Mass.[1] and the new species of gall midge *Microdiplosis pongamiae* Mani[2] in the peculiar polyp-like galls on the leaflets of *Pongamia glabra* Vent., it was discovered that the midges played a very important part in the dispersal of the mites. Ordinarily these mites are carried by wind and are wafted over long distances from plant to plant in strong gusts. But more often they are also carried by the adult gall midges in their flights.

The midges and the mites develop in the same gall, for which both of them appear to be responsible. The midges pass their larval and pupal periods in the galls. On emerging from the pupæ, the adult midges remain for a short time in the gall itself. At this time the gall cavity is over-crowded by mature mites. Some of the mites escape from the gall cavity but several of them also crawl over the legs, wings and abdomen of the midges and being of minute size, firmly cling to the midges, which do not appear to be greatly inconvenienced on this account. When these midges ultimately escape from the galls and fly away, the mites are also carried along with them and finally when the midges alight on some plant of *Pongamia* to oviposit, some of the mites drop down to the leaf. They then start life on these new plants. I have caught in and around Calcutta several midges on flight, which on examination were found to have these mites on the wings and abdomen and observations have shown that the midges have come from a distance. Galls have thus appeared on some plants in the Indian Museum compound, the mites and the midges having come from some infected plants on the maidan opposite.

This close association of the midges and the mites appears to be of mutual help to both of them. The mites have a sure chance of being safely transferred to new plants of *Pongamia glabra* Vent. (which is their food plant) by the midges. This is clearly an advantage over being blown by the wind and arriving at the food plant by chance. First the mites attack the plant and produce an invagination of the leaf surface at the place where the eggs of the midges were deposited and thus provide shelter to the developing larvæ of the midges, which also later contribute to the further development of the gall. It is thus remarkable that due to close association, same food and similar habits, the mites and the midges, have become mutually helpful, the latter helping in the dispersal of the former and in turn being provided with a shelter when young.

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[1] Massee, A. M., *Ann. Mag. Nat. Hist.*, 1933, **11.** 201.

[2] I have described this new species in my "Studies on Indian Itonididæ," shortly to appear in Vol. 36 of the *Records of the Indian Museum*.

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### Agricultural Education in India.

I HAVE been reading several articles about the necessity for establishing Agricultural Middle Schools for training young farmers. These schools were started but had to be closed for want of boys. In a country where education is meant to procure a job, it is not worth attempting to have special courses without sufficient number of appointments for the candidates that pass out. The schools would have got enough students if those that passed out could find ways and means of getting employed. Thus the same old story of the University man referred to in the said article comes about here also. Therefore the reform should, I fear, commence in the very system of education which should never allow to unmake agriculturists. Give the system of elementary education the required rural bias which many people speak of and never give employment to such as pass out of the elementary schools, so that they may freely go to the village and settle themselves down. The system of education in vogue in the Higher Elementary Schools is meant to be complete in itself and fit the boy passing out of it for rural life. Therefore, on principle it may be wrong to employ him even as a teacher. Therefore all teachers must at least be school finals even in all Elementary Schools of which the Headmasters can be graduates in Agriculture. They can easily give the agricultural colour to the elementary education better than any one else. A garden system of education can be started. If the Champion scheme of concentration is adopted, the Headmaster of one Higher

Elementary School can serve several schools in the group. Vernacular tuition in agriculture will not bring them in close contact with the scientific aspect of the subject. They have got, as it is, many items of elementary science subjects to study. All these can be so shaped that they have a rural utility and agricultural bias. An Agricultural graduate will be the fittest person to work it successfully. This reform will mean much superior kind of education to the rural folk than what they are now getting from the elementary teachers. It must practically reach all the villages in a short time and transform the system of farming in a tangible way within a reasonable period. An Agricultural School started for each district or even taluk cannot but take many years to train a number of people large enough to make the villages in a taluk feel their presence.

"ONE PRACTICAL FELLOW."

## Stray Animals.

NEITHER the Provincial Governments nor the Municipalities in India have thought it worth while to take the census of animals kept as pets and others which are not owned. A few years ago the enumeration of such animals in Europe revealed that Germany possessed the least number, and the report did not refer to Scotland. When an enterprising district officer devised an ingenious method of finding out recently the tiger population within his jurisdiction, hopes may be entertained that this shining example will not be lost on the authorities who have to deal with comparatively harmless animals.

The presence of an increasing population of animals prowling about human habitations and becoming intimately mixed up with the daily life of the people, raises a problem of great importance for the municipal authorities to solve. The Municipal Corporation in Bombay which had been carrying on the dog-catching operations recently, is confronted with the problem of keeping the stray dogs well under control. A trained staff, backed by financial resources, finds it difficult to destroy all the dogs, which somehow dodge their aggressors and try to perpetuate themselves as an integral part of the social economy of this prosperous town. The chief complaint against these animals is that during hot weather they become a source of danger, but the possibilities of pet dogs developing rabies are equally great.

Should the municipalities periodically destroy dogs which run about the streets of our towns? In a way their number and the condition of their health give us an idea of the quantity of food thrown out as waste. Do the dogs render any service to the people? They aid the municipalities in their conservancy department. They maintain a strict watch at night. The appearance of people at night, whose faces they are not acquainted with, rouse them frequently and they give a timely warning to the sleeping inhabitants. In times of scarcity, they continue to eke out a living by catching mice and bigger rodents and this is really a great service to man whose stores are raided by these small creatures, besides spreading pestilential diseases. Suppose the dogs in any locality are destroyed and precautions are taken against immigration from the adjoining districts, is there any reasonable assurance that the public health of the particular town would improve? We may diminish the number of dog bites; but in disturbing the balance of the secondary population of our towns, we may perhaps introduce unforeseen troubles. The municipalities have to conduct enquiries into the deeper issues of the complex economies of the towns under their control, before undertaking to eradicate an evil which perhaps may prove after all a blessing in disguise.

## Research Notes.

### Unternichungen zur Arithmetische theorie der Korper.

OSTROWSKI (*Math. Zeit.*, Band 39, II) has contributed a very interesting and profound work on this part of Modern algebra of which the first part has appeared in this journal and the other two parts are to be published in the succeeding numbers. The work is very extensive and is devoted on the general conception of a prime divisor in abstract fields and their extensions. The definition which he gives of prime divisor P in a field K is that corresponding to every element $a$, of the field K there exists a number $\omega(a)$ with the following properties. $\omega(ab) = \omega(a) + \omega(b)$ and $\omega(a-b) \geqslant$ Minimum $[\omega(a), \omega(b)]$. Then we say that a prime factor P corresponds to each such function $\omega(a)$. This was the definition given by Ostrowski in 1918. On account of the generality of this definition, it was doubted whether this will lead to any constructive results at all, but subsequently Ostrowski proved that in the rational field $\omega(a)$ is actually the highest power of P which divides $a$ except for a multiplicative constant. Introducing another function $|a| = e^{-\omega(a)}$, he connects this with Kurschak's idea of an assessing (Bewertung) of the field. The fundamental problem of the theory of ideals becomes the same as that of extending the function $\omega(a)$ to any given extension of the original field K, algebraical or otherwise. Now Kurschak has given a general procedure for obtaining an assessing of any given algebraical extension of a field, starting from a given assessing of the original field. Ostrowski has proved that this is the only method. In this way Kurschak's problem becomes the same as that of finding the prime factors of a prime divisor in an algebraically extended field. So that in this work there is also a simplified proof of Kurschak's theorem for these special extensions. Some difficulties which arise are solved by introducing various notions such as "A relative (with respect to P) perfect field" and so on. The conception of this field also helps us to find out what particular rôle the perfect field of Kurschak plays in the foundation of Ideal Theory. The first part ends with the discussion of the structure of a relative perfect field and their connection with various "Reduction fields" (Zerlegungs-Korpern). It is also shown that a relatively perfect field is easier to handle than a perfect field, for every algebraic extension of a relative perfect field is once again relatively perfect and that the common elements of two relative perfect fields are once again relatively perfect. The second part of the work is devoted to various divisibility questions such as the orders of prime ideals, etc. The third part gives, among other things, a justification for introducing this general idea of a prime-divisor. Various problems of reducibility of polynomials in perfect and relatively perfect fields are also proved in the first part.

K. V. I.

### Remarques sur una probleme de la theorie des nombres.

(S. Wigert, *Arkiv för Matematik, Astronomy och Fysik*, Band 24, *I*.)

RAMANUJAN was the first to show that the orders of the mean values of $\nu(n)$ which denotes the number of different prime factors of $n$ and $\theta(n)$ which denotes the total number of prime factors of $n$, are each equal to $\log \log n$. S. S. Pillay (*The Jubilee Volume of the Indian Mathematical Society*) determined further terms in the orders and obtained the best possible orders with and without the Riemannian conjecture. Now Wigert determines the orders of the mean values of $2^{\nu(n)}$ and $2^{\theta(n)}$ starting with the well-known formula

$$\sum_{n=1}^{\infty} \frac{2^{\nu(n)}}{n^s} = \frac{\zeta^2(s)}{\zeta^2(2s)}.$$

He obtains the formula

$$\frac{1}{x}\int_1^x \left[\sum_{n\leqslant x} 2^{\theta(n)}\right] dx = \frac{\psi(1)}{12\log 2}\, x \log^2 x + Ax \log x + O(x)$$

where $\psi(1)$ and A are certain constants.

### Optical Evidence for Molecular Clustering in Fluids.

THE recent issue of the *Proceedings of the Indian Academy of Sciences* (Vol. 1, No. 4) contains a paper by R. S. Krishnan who has given there positive results for molecular clustering in binary liquid mixtures based

on a study of the depolarisation of the transversely scattered light. If the incident light is polarised with the electric vector horizontal, the depolarisation $\rho_h$ should be greater than unity for a medium consisting of ellipsoidal particles of finite size and should be infinity for a medium consisting of spherical particles of finite size. R. S. Krishnan has recorded various values of $\rho_h$ at different temperatures for a mixture of dust-free carbon disulphide and methyl alcohol. $\rho_h$ is as much as 4·9 at the critical solution temperature and it diminishes as the temperature is increased but will be greater than unity till about 15° above the critical solution temperature. These results seem to give positive evidence for the formation of large molecular aggregates of size comparable with the wave-length of light even far remote from the critical solution temperature. Mr. R. S. Krishnan has no doubt opened up a new field of research and future experiments in this field may give us an idea of the size of molecular clusters in fluids.

N. S. N.

## Nuclear Moment of Caesium.

IN *Zeitschrift für Physik* of October 1934 (Vol. **91,** pp. 272-283) Hans Barth has made a detailed study of the intensity ratio of the hyperfine structure components of the caesium line $\lambda=4555$ Å and has thereby computed the nuclear moment of the caesium atom. The source used is a discharge tube containing freshly distilled caesium in a helium atmosphere at a pressure of 2 mms. excited externally by a high frequency discharge ($10^6\sim$). The analysis of the line has been carried out by the use of a Hilger echelon of 33 plates and the intensity ratio of the two components of the line 4555 Å is shown to be $1\cdot41\pm0\cdot05$ by measurements from photographic-photometry. Applying the Fermi formula for this intensity ratio, V, that

$$V=\frac{i+1}{i}$$

where $i$ is the nuclear moment, Hans Barth obtains $i=5/2$ giving for the ratio of the magnetic moments $\frac{\mu_e}{\mu_k}$ a value equal to 1170.

The values obtained in the above paper are in substantial agreement with the results published earlier by Venkatesachar and Sibaiya (*Curr. Sci.*, 1933, **7,** 303-306). The source of the caesium lines employed by them is "a vertical cooled mercury arc lamp with a tungsten anode containing a small quantity of caesium chloride", thereby effecting "a great reduction of normal caesium atoms responsible for the absorption" in the source. The rôle of the mercury vapour in diminishing the width of the caesium lines is also considered. Both the lines 4593 Å and 4555 Å ($6\,^2S_{1/2}-6\,^2P_{1/2,\,3/2}$) are analysed by Hilger-Lummer plates and the intensity ratio of the components is computed from the density curves obtained from a Cambridge Microphotometer. The intensity ratio is found to be $1\cdot408\pm0\cdot018$, giving thus a nuclear spin of 5/2 for the caesium atom. Further the Landé g (I) factor of the caesium nucleus has been shown to be 1·11. The following table is intended to indicate the agreement between these values and those of Hans Barth:

| | Venkatesachar and Sibaiya | Hans Barth |
|---|---|---|
| Lines of Caesium analysed | 4593 Å and 4555 Å $6\,^2S_{1/2}-6\,^2P_{1/2,3/2}$ | 4555 Å $6\,^2S_{1/2}-6\,^2P_{3/2}$ |
| Intensity Ratio of the components | $1\cdot408\pm0\cdot018$ | $1\cdot41\pm0\cdot05$ |
| Nuclear spin | 5/2 | 5/2 |
| $\mu_e/\mu_k$ | 1180 | 1170 |
| g(I) | 1·11 | .. |

Jackson (*Proc. Roy. Soc.*, 1934, **133,** 455-464), concludes however that the nuclear spin of the caesium atom is 7/2—a result which is perhaps due to the existence of self-absorption in the source employed. It must be remembered that self-absorption has a tendency to equalise the intensities of the two components (Venkatesachar, *Phil. Mag.*, 1925, **49,** 44) with the result that the $i$ value obtained from the Fermi formula $V=\frac{i+1}{i}$ is always in excess.

L. S.

## Refractive Index of an Ionized Medium.

THE electron theory of dispersion taught in the schools looks like a fairly settled question but recently there has been a number of discussions on the question of the conditions under which the Sellmeier or the Lorentz formula is applicable. When it is a question of getting at the optical constants by means of a range of values of the refractive index, the results can be fairly well represented by either kind of formula. But when there are other grounds for assuming particular values for the constants occurring in the two formulæ it is found that in some cases the one is right while in others the alternative is correct. Particularly in the case of metals it is found that the Sellmeier formula is appropriate and not the Lorentz formula. This question is studied in detail by C. G. Darwin in a recent paper (*Proc. Roy. Soc.*, A. 1934, **146**, pp. 17-46). He shows that the kind of argument usually given in books can be honestly turned about so as to show that in any given case both formulæ are correct although they differ in their results. He has used an entirely new type of argument to find out the conditions under which each formula is valid. He finds that in the case of a medium containing free electrons whose charge is supposed to be neutralised by a continuous distribution of positive electricity Sellmeier's formula is the correct one. In the case of a medium made up of neutral atoms the Lorentz formula is required. Considering the question of an electron gas neutralised by a proton gas, the result arrived at is that under certain conditions, which are fulfilled in the ionosphere for example, the Sellmeier formula is correct, while the cases where the argument fails are those in which the Lorentz formula is found to hold. Considering a mixture of two media, one of which obeys Sellmeier's formula and the other follows the Lorentz law, he finds that the Sellmeier function $(\mu^2-1)$ of the mixture is the sum of the Sellmeier functions of the constituents.

## Isotopes of Rare Earth Elements.

THE present-day knowledge of the isotopic constitution of most of the elements is nearly complete, thanks to the work of Aston, Dempster, Bainbridge and others. There was until recently a large lacuna in that the isotopic constitution of the rare earth elements was very meagrely known. The deficiency has been removed by Aston by his recent work published in *Proc. Roy. Soc.*, 1934, **146**, pp. 46–55. The method used by him was a slight improvement upon that described on p. 65 of his "Mass-spectra and Isotopes"; fortunately, pure salts of the rare earths were at his disposal. The results are as follows:—

| | | |
|---|---|---|
| Lanthanum .. | (57): | Simple. |
| Cerium .. | (58): | 140 (88%); 142 (11%). |
| Praseodymium | (59): | Simple. |
| Neodymium .. | (60): | 142 (36%); 143 (11); 144; (30); 145 (5); 146 (18). |
| Samarium .. | (62): | 144 (3); 147 (17); 148 (14); 149 (15); 150 (5); 152 (26); 154 (20). |
| Europium .. | (63): | 151 (50·6); 153 (49·4). |
| Gadolinium .. | (64): | 155 (21); 156 (23); 157 (17); 158 (23); 160 (16). |
| Terbium .. | (65): | Simple. |
| Dysprosium .. | (66): | 161 (22); 162 (25); 163 (25); 164 (28). |
| Holmium .. | (67): | Simple. |
| Erbium .. | (68): | 166 (36); 167 (21); 168 (30); 170 (10). |
| Thulium .. | (69): | Simple. |
| Ytterbium .. | (70): | 171 (9); 172 (24); 173 (17); 174 (38); 176 (12). |
| Lutecium .. | (71): | Simple. |

Aston remarks that there is an unexplained discrepancy between the value of the atomic weight of Erbium obtained from the mass spectrum analysis (167·24 ± 0·2) and that obtained by chemical methods by Honigschmid (165·204).

## Artificial Radio-activity.

(a) *α-Ray Bombardment.*

Ellis and Henderson (*Proc. Roy. Soc.*, **A.** 1934, **146**, 206) have made a detailed examination of the positron emission from Al, B and Mg, after the elements were bombarded by α-rays from a source of Radium (B+C). The nuclear reactions are supposed to be:—

(1) $Al^{27}_{13} + He^4_2 \rightarrow P^{30}_{15} + n^1_0$

$P^{30}_{15} \rightarrow Si^{30}_{14} + \epsilon^+$ .. (Radio-Phosphorus)

(2) $B^{10}_5 + He^4_2 \rightarrow N^{13}_7 + n^1_0$

$N^{13}_7 \rightarrow C^{13}_6 + \epsilon^+$ ...... (Radio-Nitrogen)

(3) $Mg^{24}_{12} + He^4_2 \rightarrow Si^{27}_{14} + n^1_0$

$Si^{27}_{14} \rightarrow Al^{27}_{13} + \epsilon^+$ ...... (Radio-Silicon)

Also

$Mg^{25}_{12} + He^4_2 \rightarrow Al^{28}_{13} + H^1_1$

$Al^{28}_{13} \rightarrow Si^{28}_{14} + \epsilon^-$ .. (Radio-Aluminium)

The number of positrons have been measured by a Geiger-Muller Counter. The

energy of the $\alpha$-particles necessary to cross the potential barrier of the nucleus, the periods of the decay of these short-lived radio elements, and the energy of the recoil atoms have been determined. Absorption measurements of positrons from radiophosphorus go to show the relatively fewer number of slow moving particles in the positron spectrum.

(b) *Neutron Bombardment.*

Fermi, Amaldi and others (*Proc. Roy. Soc.*, **A.** 1934, **146,** 483) have established that neutrons are more effective bombarding agents than $\alpha$-particles, protons or deutons in bringing about artificial Radio-activity in elements. More than forty out of sixty elements investigated have been activated by this method. The active element formed in each case has been identified, though the same is present in extremely minute quantities, by a process of chemical separation after mixing up with its suspected isotope. The active product formed in the case of lighter elements (Mg, Al, Si, P, S, Cr, etc.) has an atomic number less than that of the element bombarded by 1 or 2, *e.g.*

(1) $Mg^{24}_{12} + n^1_0 \rightarrow Na^{24}_{11} + H^1_1$ (Active Sodium)
$Na^{24}_{11} \rightarrow Mg^{24}_{12} + \epsilon^-$

(2) $Al^{27}_{13} + n^1_0 \rightarrow Na^{24}_{11} + He^4_2$
$Na^{24}_{11} \rightarrow Mg^{24}_{12} + \epsilon^-$

In the case of heavier elements (Br, Rh, Ag, I, Ir, Au, Ur) the active product is usually a heavier isotope of the element. $Br^{79}_{35} + n^1_0 \rightarrow Br^{80}_{35}$ (Active Bromine). Positrons have not been detected in any of the disintegrations. The problem of the capture of a neutron by the nucleus of a heavy atom has been discussed theoretically.

M. P. V. I.

## Influence of Charge on the Sedimentation Equilibrium of Colloids.

IN presenting a theoretical treatment of sedimentation equilibria, S. Levine (*Proc. Roy. Soc.*, 1934, **146A,** 597) starts with the idea that owing to the charges on the colloidal particles and the surrounding ions of the electrolyte present forming the so-called "ionic atmosphere" the two particles repel one another when their ionic atmospheres overlap. This results in the attainment of a limiting concentration which is not further affected by gravity. For calculating the magnitude of this effect he uses the Boltzmann distribution introducing an energy term associated with the charge of the particle and the surrounding ionic atmosphere. The term is evaluated as a power series in concentration of particles by using methods of statistical mechanics. The potential about a particle is evaluated by using the differential equation employed by Debye and Huckel in their theory of strong electrolytes. The results indicate departure from the Perrin's law varying according to charges on the particles and the concentration of the electrolyte present from $n$ (the number of particles per millilitre) $=1{\cdot}6\times10^{13}$ to $n=4{\cdot}0\times10^{14}$, with corresponding limiting concentrations lying between $n=2{\cdot}1\times10^{14}$ and $n=5{\cdot}5\times10^{15}$.

As the author has pointed out, the influences of factors like hydration and electrostriction have not been considered. This possibly accounts for the fact that the new theory does not reproduce the limiting concentrations observed by Porter and Hedges and by Barkas.

K. S. G. D.

## Plant Families in relation to Some Chemical Properties.

IN his contribution to the *American Journal of Botany*, 1934, **21,** 427, Mr. Nair has discussed the evolutionary status and climatic distribution of plant families in relation to the physical and chemical properties of the glycerides, volatile oils and alkaloids isolated from them. The analytical data refer to 318 fats, 232 waxes, 938 volatile oils and 299 alkaloids, obtained from 83, 84, 87 and 57 plant families respectively. The families that produce these materials may be divided into six climatic groups, *viz.*, tropical, tropical-sub-tropical, sub-tropical, sub-tropical-temperate, temperate and widely distributed. The data have been statistically examined and it has been shown that there is a consistent variation in some of the physical and chemical properties of the materials according to the climatic distribution of the plants. Thus, the tropical and sub-tropical glycerides possess higher melting points and lower iodine values than the fatty oils of temperate climates. The data concerning refractive indices and specific gravities suggest that the tropical volatile oils have constituents of greater saturation. The average molecular weights of alkaloids are lower and the average melting points higher in the tropical than in the temperate

plants. These data indicate that in general more complex compounds are formed in temperate than in tropical plant families. The physical and chemical properties of the compounds also vary in accordance with the degree of evolution of the plant families containing them and the more highly organised the plants are, the more complex are the chemical products elaborated by them.

B. N. S.

## The Development of the Trout Scale.

THE March issue of the *Journal of the University of Bombay* (Vol. **2,** part v, pp. 17—32, 4 pls., 1934) contains an interesting article on the development of the Trout Scale by Dr. S. B. Setna, Fisheries Officer with the Government of Bombay. Apart from the excellence of the technique employed and of the histological details worked out, such a study is valuable in fishery work, for "It is well known that the sclerites in some fish formed during the summer are wide apart, while those formed in winter are nearer together. The surface of the scale is thus mapped out into well-marked regions: the summer and the winter bands. In other words, the scale denotes a well-marked rhythm. The facts of development have been utilised for determining the age of the fish." The author has suggested that the formation of the bands is due to the intermittent growth of the scale pocket and to the several tensions and pressures to which the scale is subjected during growth.

In India, the study of fish scales is a desideratum which requires an early attention. Such a study will not only help the development of pisciculture in the country, but will yield data of great biological significance. In the Punjab and the United Provinces, the summer and winter months show extremes of temperature, and the scales would probably be found to exhibit a well-marked rhythm. In Lower Bengal and Madras, on the other hand, the two seasons are not well-marked and in consequence, the sclerites may show a more or less uniform growth throughout the year. As this type of research is of economic importance and especially well suited for the zoology departments of the various universities in India, it is hoped that some interest will be taken in the problem in the near future.

S. L. H.

## The Structure and Relationships of Lamellibranchs.

ALASTAIR GRAHAM in an important paper (*Proc. Roy. Soc. Edin.*, 1934, **54,** Pt. 2) examines the lamellibranchs belonging to the groups Tellinacea, Solenidæ and Solecurtidæ and draws certain conclusions regarding the phylogeny of these groups. Of the above, the Tellinacea and the Solecurtidæ possess a cruciform muscle while it is absent from the Solenidæ. Based on this character and others are his conclusions that the Solecurtidæ are more nearly related to the Tellinacea than with the Solenidæ.

## Cestodes from Lucknow Pigeons.

L. N. JOHRI has described a number of cestodes from pigeons and a few other animals round about Lucknow (*Rec. Ind. Mus.*, 1934, **36,** Pt. 2). It has been observed by the author that regarding the infection of the pigeons at least, birds from the slum areas of the town feeding on poor corn were intensely infected, while wild forms from the rural areas showed less or no infection at all. He thinks that the intermediate host is a weevil or some other arthropod feeding on corn. Heavy infection by Raillietina produced fatal results among the hosts. The author describes a new genus, a few new species and a number of sub-species and varieties. No useful purpose is served by the multiplication of specific names and while a description of outstanding characters meriting the formation of new genera should be welcomed, little differences in dimensions, colour and such other characters and the creation of new species on these characters would only result in the production of a quantity of confusion.

Another paper by B. S. Gogate describing a few new species of Trematodes from the wild ducks of Rangoon appears in the same number of the journal.

## "In Vitro" Culture of Pulmonate Molluscs.

J. C. HILL (*Journ. Roy. Micros. Soc.*, 1934, **54,** Pt. 3) has summarised our knowledge of the "in vitro" technique with reference to the Pulmonate molluscs. Prof. Gatenby and the author have done much work on this subject and a number of useful aseptic and artificial media have been devised for the growth of cells from

the gonad of these molluscs. The author was the first to use the Hedon Fleig solution in which medium the cells lived for a long time and developed regular connective tissue networks. Bohuslav's modifications of these methods, though resulting in a prolongation of the life of the cells did not produce any extensive outgrowths.

### Minor Chemical Constituents in Some Igneous Rocks.

A VERY interesting article on the minor chemical constituents of igneous rocks has been contributed by G. H. Harcourt in *Journal of Geology*, **42,** No. 6. The investigation of rare constituents like Ba, Zr, Mn, Sr and such other elements is determined through spectrographic means. Taking Granites as an example, he has shown that the majority of the minor constituents are common but the variations of their percentages are rather erratic. By studying the occurrence of Silver as a minor constituent in some Granites he has shown that this is characteristic of a particular type of the Granitic magma. On this basis he has suggested a similarity between the Lansdowne Granites and Granites of Rainy lake. If it is possible to establish different types of rock suites by the determination of minor constituents in igneous rocks, it will not only be a great factor in elucidating petrogenesis, but will also go a long way in locating certain types of ore deposits.

### Some Pseudo-Eutectic Ore Textures.

IN a recent article in *Economic Geology*, **29,** No. 6, A. L. Anderson discusses the occurrence and development of intergrowths in sulphide ores. By studying such intergrowths in a number of cases such as Galena-Calcite, Galena-Pyrargyrite and Tetrahedrite-Galena he concludes that these textural peculiarities are due to replacements of one mineral by another. In one case he has actually traced the irregular advance of pyrargyrite into galena along convex fronts in addition to tongue-like projections. The replacements are mostly physical in nature and are not accompanied by any changes in volume. Further he has shown that these textures in ores are mainly hypogene replacements, and are comparable to the pseudo-eutectic textures advanced by Lindgren.

## Dipole Moments.

DURING the last decade considerable progress has been made towards a precise and quantitative interpretation of the structures of molecules. Among the several methods employed towards this goal Raman spectra and Dipole moments have stood out prominently as they are directly applicable to a study of the more complicated molecules, which have been so extensively studied by chemists and which are not easily amenable to other physical measurements.[1] The interest in the dipole moment of the molecules is particularly enhanced by the apparently simple manner in which it takes account of mainly those parts of a complex molecule which are already known as the seats of chemical reactivity. From the time of the pioneering work of Debye and his colleagues in 1912 and onwards, the interest in the subject has been rapidly increasing, and a large volume of careful experimental work has been turned out mainly during the years following 1924. It was a happy idea therefore for the Faraday Society to devote its Sixtieth General Discussion to the subject of "The Determination and Interpretation of Dipole Moments". The discussion which was held at Oxford from April 12 to 14, 1934, under the Presidentship of Professor N. V. Sidgwick, F.R.S., was attended by almost all the important contributors to the subject and has since been published as a special number of the journal.[2] There are in all twenty-four contributions reviewing and discussing every phase of the subject. There is in addition a very valuable classified index of all the moment values determined up to the time, together with the connected details of temperature, method and actual values of polarisation for each substance.

The aspect of the subject which has held the wide interest of the chemists is the original observation of J. J. Thomson[3] which was more fully developed later by Eucken and Meyer[4] that a moment of a definite value could be associated with a bond and with the direction of the bond, so that provided there is no mutual interaction the observed value of the moment of a complex molecule is given by the simple law of vector addition. Later and more careful observations have shown that the above formulation is only approximately valid. C. P. Smyth (p. 752) has reviewed the present position in regard to this and has shown that a bond moment is merely a measure of the electrical unsymmetry of a certain section of a molecule and is affected by the environment of the section. It has not been possible so far to calculate exactly the induction

[1] E. Rabinowitsch, *Naturwiss.*, 1934, **28,** 477.

[2] Pp. 679–904 + lxxxvi; price 21*sh*.

[3] *Phil. Mag.*, 1923, **46,** 513.

[4] *Phys. Z.*, 1929, **30,** 397.

effects of a dipole on the other polarisable parts of the molecule as it is difficult to estimate the actual location of a dipole. Approximate calculations, however, in the case of the halogenated methane derivatives indicate the reality of these effects. There is in addition a possibility of at least a small shift of charges not immediately calculable from induction. Such shifts—electromeric effects—are more conspicuous in aromatic and unsaturated compounds. G. M. Bennett (p. 853) has estimated the additional moment due to this effect in a series of *p*-substituted anisoles, and concludes that when this is taken into consideration the valency angle of oxygen calculated from the moment values are more nearly in agreement with the values estimated by other methods. Some other striking instances where the simple vector law of additivity of moments breaks down are discussed by A. Weissberger, R. Sangewald and G. C. Hampson (p. 884). The three monochloro diphenyls with the chlorine in 2, 3 and 4 positions have different moments, 1·3, 1·8 and $1 \cdot 5 \times 10^{-18}$ e.s.u. respectively, although diphenyl itself has moment zero, and chlorobenzene has moment 1·5. Similarly, $\alpha$ and $\beta$ chloronaphthalenes have different values of moment. As the moments of the corresponding dichlor diphenyls are complicated by the possibility of rotation around the diphenyl link, a series of ten disubstituted chloronapthalenes have been synthesised and their moments studied. The results indicate that there is a particular shift of electrons in the molecules toward the substituents, and this shift contributes a moment of the order of 0·2 in a direction perpendicular to the bridge bond. However, when substituents are introduced in the same positions in both rings the polarisation in question does not occur. It has also been shown elsewhere[5] that an influence of this order exists in quinoline and isoquinoline. O. Hassel (p. 874) has discussed the information that can be gathered regarding the stereochemistry of cyclohexane from a study of the dipole moments of the halogen derivatives of the same. Most of the results go to show that at ordinary temperatures in the solution state the high-symmetric *trans* form of the ring is by far predominant and stable. In a discussion of this paper, J. D. Bernal points out that a transformation from the *trans* to *cis* form should involve not only considerable activation energy but also a definite transition energy. J. E. W. Le Fevre, on the other hand, shows that the moment of 1 : 4 cyclohexadione indicates that this derivative definitely exists in the two strainless forms foretold by the older stereochemistry.

Pauling and his collaborators have recently shown that a large number of molecules exist with the same nuclear structure but in different valency states, *i.e.*, with different electronic structures. All these component structures exist simultaneously in a *resonance* equilibrium, the actual ground state possessing an energy equal to or less than that for any of the individual structures, the difference, called the resonance energy, giving a measure of the stability of the molecule compared to that of any of the parent states. This resonance affects other properties of the molecule as well; thus the inter-nuclear distances and the valency angles assume intermediate values which are usually disproportionately near to those in the stiffer structures. In his report L. E. Sutton (p. 789) has gone into this question in considerable detail from the dipole moment point of view and finds that in several instances, *e.g.*, isocyanates, $N_2O$, etc., the observed moment can be best accounted for by taking into consideration the several possible structures in resonance. In another extremely lucid paper N. V. Sidgwick (p. 801) has analysed all the evidences in favour of the three possible structures for the organic azide radical

$$\text{(I)} - N\langle{}^{N}_{N}\,\|\,,\quad \text{(II)} - N = N \underline{\rightarrow} N,\quad \text{(III)} - N \leftarrow N \equiv N,$$

and comes to the conclusion that the azide radical is a mixture of the two open chain forms II and III in resonance. This phenomenon of resonance is then discussed at length by several members present, beginning with the President's very apt remarks about possible limitations to the various permissible resonating formula for one and the same nuclear structure. It may be added here that recent studies of the moments of picolines and quinolines (M. A. Govinda Rau and B. N. Narayanaswamy, *loc. cit.*) also support the existence of resonance in these molecules.

There are on the other hand a large number of molecules in which the nuclear structure itself is not rigid, such as those in which free rotation is possible about a single bond. The moment of such molecules is generally dependent on the temperature in as much as the extent of deformation of the molecule is governed by the intra-molecular potentials and the degree of thermal agitation. In many cases where rotations are possible the moment is still independent of temperature indicating that the molecules are locked up in definite oriented positions, sometimes due to the existence of quantum resonance. C. T. Zahn (p. 804) has reviewed his own considerable contributions to this subject, while J. E. Lennard-Jones and H. H. M. Pike (p. 830) have pointed out some interesting complexities in the mechanics of this free rotation, such as in the case of dichloro ethane where the principal axis of rotation passes through the two chlorine atoms for the *trans* model and gradually shifts on to a position between the Cl—Cl and C—C lines for the *cis* state. Another mathematical investigation by W. G. Penney and G. B. B. M. Sutherland (p. 898) in which the quantum mechanical method of electron pairs is applied to the structure of $H_2O_2$ and $N_2H_4$, leads to the conclusion that these molecules are not symmetrical but have unsymmetric skew structures, and the moment values calculated for such structures are in good agreement with the observed values. An extremely interesting paper in this connection is that of G. C. Hampson (p. 877) who finds that the symmetrical linear arrangement ascribed to the dicovalent compounds of mercury, such as the mercury halides, is not supported by the observed finite moments for the *para* disubstituted derivatives of mercury diphenyl. It is suggested that there is a considerable degree of flexibility in these molecules, the Hg—C link having a certain angle of swing. In the accompanying discussion de Laszlo has confirmed this suggestion of Hampson and estimates the actual angle to be about 30° from his electron diffraction

[5] M. A. Govinda Rau and B. N. Narayanaswamy, *Z. Physikal. Ch.* (*B*), 1934, **26**, 23-44.

experiments with the vapour of dibrom diphenyl mercury.

The rest of the contributions to this symposium deal with the more physical aspects of the subject, such as the influence of the solvent on the calculated value of the moment (F. H. Muller. p. 729). It is now recognised that the moment obtained decreases with the increasing dielectric constant of the solvent, but there is no general agreement regarding the exact law by which this decrease takes place. A logical formula that can eliminate this solvent influence and thereby allow of an exact evaluation of the moment for the free molecule, will be a considerable advance on the present-day technique of determining the moments of molecules. The potentialities of the Raman-Krishnan theory in this direction are emphasised by F. R. Goss and E. G. Cox, in the discussion that follows, and P. Debye has pointed out that since solvent influence is measured by the dielectric constant, the solvent molecules near the dipole molecule are not the only ones involved. A direct consequence of this reducing influence of dielectric constant on the calculated polarisation is to vitiate the Debye law of linearity of polarisation with 1/T when determined by the infinitely dilute solution method. The resulting decrease in the slope of the P–1/T line and therefore of moment and the fictitious high values for the atomic polarisation are illustrated in a separate communication by H. O. Jenkins (p. 739) with his experimental results on the polarisation of nitrobenzene in dekalin at 25° and 142°. The reported values of atomic polarisation are further discussed by S. Sugden (p. 734) who finds that no clear relationship can be traced between moment and $P_A$ nor can finite $P_A$ values be allotted to groups. In contrast to the well-investigated cases where the calculated polarisation decreases from the gaseous measurements to those in solutions, F. Fairbrother (p. 862) has observed a considerable increase in the polarisation of the hydrogen halides when dissolved in benzene and in $CCl_4$. The suggested explanation is that owing to the smallness of the molecules, the induced dipoles in the surrounding solvent molecules will be large and their effect will tend to increase the electron density at the halogen end of the molecule, or in other words, transform the covalent link to an ionic binding. In the keen discussion that follows there is no agreed opinion regarding the suggested explanation. The nature of the bond, whether ionic or atomic, the binding energies and the internuclear distance, and their bearing on the dipole moment are discussed in a separate communication by W. H. Rodebush (p. 778).

The rôle of interdipole forces on the polarisation and other physical properties are discussed in a series of three papers. The interaction energy between two dipoles at a distance $r$ apart is proportional to $\frac{\mu^2}{r^3} \propto n\mu^2$, where $\mu$ is the moment and $n$ the number of dipoles per unit volume. Van Arkel and J. L. Snoek (p. 707) have showed that the simplest empirical equation in which this energy term can be successfully introduced is

$$\frac{\epsilon-1}{\epsilon+2} = \frac{4\pi n}{3}\left(\alpha + \frac{\mu^2}{3\,\mathrm{KT}+c\,n\mu^2}\right)$$

where $c$ is a constant independent of solvent, concentration or moment, so long as there is no intermolecular association. Indeed this equation can be used to furnish a sharp criterion for the existence of association from the abnormal values obtained for $c$ and the influence of solvent, etc., on the same. In another communication A. R. Martin (p. 759) seeks to estimate the nature of the interdipolar forces from the curvature in the partial vapour-pressure—composition curve of solutions of dipoles. This same interdipolar energy between the dipole molecules in a pure liquid contributes an additional term to the cohesion energy due to purely London forces. Van Arkel (p. 698) has shown that the rise in the boiling point of the liquid due to this additional term is given by $T_D = 1{\cdot}53\times10^3\times\frac{P_0\,\mu^2}{R^3\,V_B}$, where $T_D$ is the Debye contribution to the boiling point, $P_0$ the optical polarisation, R the mean radius of the molecule, and $V_B$ the molecular volume at the boiling point. In larger molecules, the distance between constituent dipoles when appreciable must also be taken into consideration and this helps to predict the order of succession of boiling points in a group of isomers.

Another physical characteristic of a dipole molecule is the finite time it takes to orient itself in the direction of the applied field. This is the theme of P. Debye (p. 679) for his opening contribution to the whole symposium. When the period of oscillation of the applied field is of the same order as the time of relaxation of the molecule, a difference in phase is set up between the field and the polarisation with accompanying energy absorption and decrease in dielectric constant. Of these the energy absorption is a first order effect, and measurements of high frequency losses particularly in dilute solutions—for which alone the equations are valid—should give absolute values of the relaxation time $\tau$ according to the formula

$$\mathrm{W} = \left(\frac{\epsilon+2}{3}\right)^2\frac{\omega^2\tau}{2\mathrm{V}}\cdot\frac{\mathrm{N}\mu^2}{3k\mathrm{T}}\,f\,\mathrm{E}^2,$$

where W is the energy produced in ergs per c.c. and per second, $\epsilon$ the dielectric constant of the non-polar solvent, E the amplitude of the applied field, $f$ the mol. fraction and V the molal volume of the solvent. J. Malsch and G. Martin have developed the necessary technique for these measurements. The results show that different values of $\tau$ for one and the same molecule in different solvents are far from proportional to their viscosities as will be expected from Stokes' formula. $\tau$ is probably an individual characteristic constant depending upon the particular form of the molecule. P. Girard (p. 763) has studied the dielectric constant and dispersion of a number of alcohols and finds evidence for the existence of association complexes. In polyhydric alcohols the association complexes are polar in character with different dispersion regions, and break down with rise in temperature. On the other hand, tertiary alcohols are typical examples where non-polar association complexes are formed. J. W. Williams (p. 723) has described briefly some experiments to verify quantitatively Debye's theory of dispersion, and to apply the equations to calculate the molecular weight of proteins from the relaxation times. In certain cases good agreement with experimental values of molecular weight have been obtained, but in others discrepancies have appeared. The sources of error and

attempts to solve them are discussed. Debye's formula seems also to be applicable, at least roughly, to solutions in polar solvents such as alcohol and water.

The free orientations of dipole molecules are even more hindered when they are located as in a crystal lattice, on account of the strong internal potential fields. Still the existence of a pronounced dispersion as in ice points to a probability for spontaneous passage of a molecule from one direction to another. J. Errara and H. Sack (p. 687) find a similar dispersion also in the crystals of magnesium and yttrium platinocyanides and attribute this to the existence of one or two very loosely bound water molecules per platinum atom. It is also observed that the orientation of the field with respect to the axes has a pronounced effect.

When an ionic lattice is placed in an electric field there is an additional polarisation due to the relative displacement of ions. This additional polarisation increases with rise in temperature while the usual volume polarisation decreases. E. Bretscher (p. 685) has calculated the resulting temperature coefficient of dielectric constant on the basis of the existing theories of interionic potential for the case of NaCl and $CaF_2$ crystals, and finds a discrepancy between calculated and experimental values, which is attributed to certain imperfections in the theory.

The symposium is thus seen to cover almost the whole field of the dielectric properties of matter, and when taken along with the exhaustive table of moments given as an appendix, this volume of the *Faraday Society Journal* is easily the most up-to-date guide to the subject of Dipole Moments.

M. A. GOVINDA RAU.

## Industrial Possibilities of Some Research Work done in India.*

ALTHOUGH, prior to the time of the Great War, efforts at industrial developments in India were not wanting, yet, the phenomenal enthusiasm for the starting of new industries and the serious attempts to explore and exploit industrial possibilities in the country witnessed during the period 1916-18, can be directly traced to the stimulus given to industrial research by the Great War. Since then, the interest has been, more or less, kept up and energetic steps are now being taken by the Central Government to investigate market conditions and centralise research work in industries.

Original work carried out in recent years holding out industrial possibilities, can be reviewed under 5 heads:—(*a*) Researches resulting in permanent factories, (*b*) Researches resulting in factory operations still in the initial stage, (*c*) Researches resulting in factories operating on a commercial scale, but which for various reasons, have been discontinued, (*d*) Researches which have been of proved commercial interest, but which have not been fully exploited, and (*e*) Researches that await commercial consideration.

The researches pertaining to the distillation of sandalwood oil, the utilisation of local oils for soap manufacture and the manufacture of turpentine may be mentioned as examples which come under the first group. Under the second category, comes the manufacture of ceramic wares and gas mantles. Acetone with increased demand under the exigencies of War, may be cited as an instance of a temporary industrial venture. Other industries which may be mentioned in this connection are the manufacture of glue and gelatine, thymol and strawboards. The manufacture of glue deserves careful consideration; a material of a somewhat inferior quality can be produced as a cottage industry and may therefore prove of particular interest to India.

Researches of proved commercial importance but which have not been fully exploited, deserve special consideration. They concern improvements in large-scale industries already existing in India. The lac industry is a case in point. It is now faced with competitive synthetic substitutes on all sides, but possesses certain virtues which give the natural resinous product a distinctive character; the latter, therefore, cannot be easily substituted. This is particularly true in the manufacture of electrical insulators, where the decomposition products of lac which may be formed when exposed to high electrical pressures, are still non-conducting, which is not the case with similarly formed products from artificial substitutes. By imposing a strict scientific control during the various stages of the industry—production, manufacture, storage and transport, and exploiting the by-products of the factory, it should be possible to set the whole industry in order and the natural lac will undoubtedly hold its own against competition.

Another industry which offers considerable scope for improvement, is the fibre industry. In the year 1931, of the 3½ million tons of coir produced for spinning, only 1/10 million tons were used, and here is ample room for enterprising inventive genius to utilise the waste. The short fibres which can be recovered from the cotton seed appears to be quite suited for paper manufacture, and the pre-treatment of this and other cellulosic materials for paper manufacture demand careful and systematic enquiry. Fermentation or "retting" may be found cheaper than chemical treatment. Other varieties of fibres that are available in India are the *sann* hemp, linseed straw, megasse, rice straw and bamboo.

The problems of the oil industry in its many ramifications are so numerous that there is ample room for continued activity. The proposed Technological Laboratory at Nagpur to be subsidised by the Lakshminarayan bequest intends to take up the subject, and it is hoped that fresh lines of enquiry may be opened up.

The question of power alcohol has been in the minds of Indian technologists for many years, but although the country abounds in exceptionally cheap raw materials, such as mahua, cassava and artichokes whose utility as raw materials have been tested, the production of alcohol has not proceeded much beyond the laboratory trials. Papaya has been shown to

* Abstract of a course of two lectures delivered by Dr. Gilbert J. Fowler, D.SC., F.I.C., under the auspices of the Society of Biological Chemists, India, on the 22nd and 26th October 1934.

contain more fermentable sugar per acre than any other crop in India, and holds out vast possibilities for industrial exploitation.

Another source of natural wealth which requires only energy and persistence to be utilised with great benefit to the food supply of the mass of the population, is human and animal wastes including activated sludge which can be employed as a starter for composting town and farm refuse thus yielding a valuable fertiliser.

Other industries whose progress can be ensured by systematic laboratory investigations are the dyeing industry, wood distillation, chromium products, refining of crude saltpetre, preparation of papain and manufacture of vinegar.

A large proportion of the literature that has accumulated, concerns those problems, which await commercial consideration. To mention only a few, a good deal of work has been carried out on cereals and cereal products, and in the fruit and vegetable industry including its by-products, such as, papain, pectin, tartaric and citric acids, beverages and condiments. With the exception of rose water and sandal oil, little effort has been made to develop the possibilities of perfumes from Indian flowers and scented grasses. The economic handling of the enormous quantities of molasses from sugar factories, and its utilisation, presents numerous problems awaiting solution.

The argument that, provided raw materials could be exported with profit, it would be unnecessary to spend money in setting up factories to utilise the raw materials and convert them into useful commodities, is illusory since it disregards the importance of the circulation of wealth. There is a considerable field in India, to-day, for small industries requiring comparatively little capital, and no opportunity should be lost to exploit them. The large-scale industries require not only considerable capital, but also courage and vision. A country which has produced Jamsetjee Tata may hope for other captains of industry.

"Ultimately all wealth must come from land since men cannot live without food. In India, it cannot be doubted that every effort should be directed towards a more intensive agriculture. .............Improved agriculture should render possible a higher standard of life in the countless villages of India; and with this higher standard a greatly increased demand for the products of mechanical industry."

B. N. S.

## Science Notes.

*Acetyl Group in Lignin.*—Mr. Pulin Behari Sarkar of the Dacca University writes: "The fact that wood and other lignified materials when distilled with dilute mineral acids afford acetic acid, has caused several investigators to assume that lignin contains acetyl groups. This is still an unsettled fact, as no lignin preparation uptil now has been found to give acetic acid under similar conditions. According to Jonas (*Papier Fabrikant.*, 1928, **26**, 221) the acetyl group is split off from lignin by very strong HCl during isolation even in the cold. He includes therefore an acetyl group in his modification of Schrauth's formula. Heuser (*Paper Trade Jour.*, 1930, **83**, 75) also considers the acetyl group as characteristic of lignin.

"Raw jute but not lignin, even when separated with 42 %HCl under the mildest conditions, gave acetic acid on distillation with dilute $H_2SO_4$, or on being first boiled with KOH and then steam distilled after acidification with $H_2SO_4$. Acetic acid was estimated in raw jute and jute delignified with $ClO_2$ without any previous boiling with 1 % alkali. It has been found that raw jute gave 6·26 % acetic acid while delignified jute gave 7·54 %. As jute contains 15·43 % of lignin, 100 g. of raw jute means 84·57 g. of delignified jute. Again, since 100 g. of delignified jute gave 7·54 g. of acetic acid, 84·57 g. of it would give 6·37 g. of the acid. Actually, raw jute gave 6·25 % acetic acid, which fact therefore proves in an indirect way the absence of acetyl group in lignin."

* * *

*Absence of Aldehydo-group in Lignin.*—Mr. Pulin Behari Sarkar of the Dacca University writes: "In a former communication (*Curr. Sci.*, 1934, **2**, 406) it has been pointed out by the author that the reducing action of lignin is due to the two OH groups attached to the benzene ring in the ortho-position. Further proof has now been obtained for this from the results of methylation.

Lignin isolated by 42 % HCl at room temperature has been separated into two fractions by dilute NaOH. The soluble portion which reduces Fehling's solution very readily, has been methylated with dimethyl sulphate and 45 % KOH at a temperature below 25° (Urban, *Cellulose Chemie.*, 1926, **7**, 73). After a single treatment the reducing property diminished considerably and after the second, it disappeared altogether. The colour changed from deep black to light brown and the product no longer dissolved in alkali. As only the OH groups are attacked by dimethyl sulphate in presence of alkali, the absence of reducing property in methylated lignin therefore proves conclusively that lignin contains no aldehydo-group.

It may be mentioned here that the loose combination of dimethyl sulphate with the CHO group as in the case of sugars, breaks up easily on warming with dilute acids or alkalis."

* * *

*Harvesting Sugarcane.*—Mr. Y. K. Raghunatha Rao, Chemist, Mandya Sugar Factory, writes: "To know when a sugarcane crop is ripe for harvesting it has been the practice to cut down several stalks, send them to the factory for pressing out in a handmill and analyse the juice. Lately the method is the inexpensive and simple one of noting the 'Brix' or density of the juice from the cane in the field with a hand refractometer, the point of sampling being about the middle of the stalk. The pith is bored out from an internode of the cane with a 'Gempol' knife and pressed to give a drop or two of the juice, whose Brix is noted. A variant of the method is to collect the juice drops from all the stalks in four selected stools and observe the brix of the mixed sample.[1]

[1] *I. S. J.*, 1933, pp. 37, 274, 359; 1934, pp. 235, 240, 320.

A slightly different procedure was followed in testing the sugarcane fields at Mandya. The pith of the cane was not bored out. The juice was taken out of the cane directly by a grooved knife (Zeiss) or by means of a pair of tongs with sides broadened so as not to injure the cane and fitted on the inside with a piercing button and grooved so as to let out the juice.[2] Errors due to evaporation and insufficient cleaning out of the former juice sample should be guarded against; in this respect the knife is simpler. Every fifth internode from the visible air roots was sampled.

No. of canes examined 48. Variety H.M. 320. 12 months old.

TABLE I. (Brix)

| Internode | 5th | 10th | 15th | 20th (top.) |
|---|---|---|---|---|
| Stool I. | 21·1 | 20·7 | 20·1 | 17·3 |
| ,, II. | 21·3 | 21·6 | 22·6 | 20·7 |
| ,, III. | 20·8 | 21·7 | 21·5 | 20·1 |
| Calculated Total | 21·1 | 21·26 | 21·26 | 18·2 |
| Observed Total | 21·2 | 21·30 | 20·60 | — |

TABLE II. (Brix)

| | 5th | 10th | 15th | 20th (top.) |
|---|---|---|---|---|
| Stool IV. | 21·5 | 22·4 | 20·0 | 17·1 |
| ,, V. | 22·7 | 22·7 | 22·6 | 21·0 |
| ,, VI. | 22·2 | 22·9 | 22·8 | 21·9 |
| Calculated Total | 22·2 | 22·7 | 22·0 | 21·0 |
| Observed Total | — | — | 22·2 | — |

From the results it is found that a collective sample from the middle of the stalks is a fair average. However, such a sample does not distinguish between ripe and nearly ripe cane. The convergence of the brixes of the top, middle and bottom parts is a better criterion. In unripe canes the brix at the middle is more than at the bottom and much more than at the top. The values are nearly equal at ripeness, the limit of divergence being ± 1° Brix.

The ripeness test should therefore consist in collecting separately average samples from the top, middle and bottom of all the canes in four or five selected stools, proper weight being given to damaged or borer attacked canes and noting the brixes of the three average samples. When the three values are nearly equal the cane is ripe. This method involves no greater expense or labour and is a very reliable one."

* * *

*Asiatic Society of Bengal.*—Among the interesting exhibits that were shown and commented upon at the recent meeting of the Society held on the 5th November, were six China plates, representing the three famous Buddhist pilgrims. These were exhibited by Mr. Johan van Manen. "Genuine Chinese porcelain is as famous as its fakes are feared. India has in the course of its history absorbed a substantial amount of valuable specimens of Chinese ceramics, which come to light from time to time, and after the great European War, Calcutta has become an important dispersion centre for old China, both genuine and spurious. The plates exhibited represent the three famous Buddhist Pilgrims, Fa Hsien, Hsuan Tsang, and I Tsing. The period mark gives the date of manufacture as that of Hsuan Ho, the one but last Emperor of the first Sung Dynasty, *i.e.*, A.D. 1119. This is almost unbelievable, though some Chinese friends who have been consulted think the plates probably genuine."

* * *

*A New Technique of Micro-Analysis.*—Dr. Charles Rosenblum of the University of Minnesota has evolved a new technique of micro-analysis for determining extremely minute quantities of chemical elements. Many of the heavier elements have radio-active isotopes which are chemically indistinguishable from them, but which make their presence known by their disintegration and are detectable by physical methods. The proposed method consists in adding to the solution of the element, a small amount of radio-active element with which it is isotopic. The mixture is chemically inseparable, yet the amount of radio-active disintegration detectable is a measure of the concentration of the inert element. "If now a fraction of the element is removed from the solution by precipitation or electro-deposition, the same portion of the radio element is simultaneously removed; the radio element thus acts as an indicator of the inactive element."

* * *

*Enzymic defence against Cancer.*—The possibility of treating cancer by artificially stimulating the enzyme activity of an organ in order to aid the natural defensive mechanism of the body has been foreshadowed by the work of Dr. E. F. Schroeder and Dr. Ellie MacDonald of the Cancer Research Laboratories of the University of Pennsylvania. Arginase occurs in large quantities in the tumourous tissue and is closely associated with rapid growth processes; at the same time the arginase normally present in the liver decreases as the tumour grows. The concentrations of two other enzymes in the tumour—cathepsin and phosphatase—on the other hand, diminish as the cancerous growth becomes more necrotic. Phosphatase, in particular, is found in high concentrations in the kidneys of rats resistant to cancer. "The implanted cancer tissue might liberate into the blood stream certain enzyme activators or stimuli, which would cause other organs to respond by setting up a defensive mechanism in the form of increased enzyme activity. If the stimulus is sufficient the animal may throw off the cancer; if not the cancer grows. This opens an interesting field in the possibility of artificially stimulating enzyme activity of an organ as a defence against further growth of the cancer."

* * *

*Air Conditioning.*—Dr. Moscicki, one of the most eminent chemists in Poland and President of the Republic, has invented a device whereby the air of sick rooms may be conditioned so as to simulate that of a mountain resort. He has succeeded in reaching his objective of greater purity, a higher percentage of ultraviolet rays, a greater degree of ionisation, and a lower atmospheric pressure together with the introduction of small amounts of ozone (*Ind. Eng. Chem., News Edition*, 1934, **12**, 317).

* * *

*A New Colour Exhibit in the American Museum.*—According to a report in the *Natural History* (1934, **34**, 589) an interesting colour exhibit of special interest to naturalists has been arranged in the Hall of Reptiles of the American Museum. The exhibit includes living specimens showing

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[2] *Sugar News*, 1934, p. 306.

three types of colour mutations, a bright yellow variety of the common pond frog, a black melanistic form of the garter snake, and a red variation of the chicken snake. By way of comparison a normal specimen of each species is also included.

The green colour of the normal pond frog is due to a reflection phenomenon. The rays reflected by certain guanine-containing cells backed by black pigments, pass through a filter of oil-containing cells thus imparting a green appearance to the skin. The yellow "sport" lacks the black pigment cells and the consequence is that the short light waves are not reflected back through the yellow filter, the skin therefore appears yellow, not green. Mutations or germinal changes are the first stages in the formation of new species and the various colour "Sports" are of special interest to the naturalist.

* * *

*Bombay Government Fishery Scheme.*—In our issue for November 1933 (" Science News", p. 184) attention was directed to the steps taken by the Government of Bombay, in pursuance of the recommendations made in Mr. H. T. Sorley's Report, to improve the supply of fish to the city of Bombay by introducing a system of transporting fish from the fishing grounds to the city by motor launches. It will be learnt with considerable satisfaction that the scheme has proved useful and that within one year the Government has already launched a third motor vessel in connection with the scheme. It is also learnt that enquiries are being made by the local fishermen regarding the feasibility and cost of converting ordinary fishing crafts into power boats. It may, therefore, be presumed that the local fishermen are beginning to realise the benefit to their trade by the adoption of rapid and modern forms of transport. The progress of the small beginning made by Bombay in improving its fish trade should be watched with keen interest by other parts of India, especially Bengal and Madras, where primitive transport methods are still employed, in spite of an increasing demand for fish and a consequent rise in prices.

It is not yet fully realised that Fishery Industry is next only to Agriculture in this country. To relieve the distressing poverty of the masses and to improve their diet, it is absolutely essential to develop the fishery resources of India along scientific lines at an early date as was pointed by us in the October issue of 1933.

* * *

*Report of the Zoological Survey of India.*—A copy of the report of the working of the Zoological Survey of India for the years 1929-32 has been received by us. The Survey which is associated with the Indian Museum is the premier Zoological institution in India and has a library which is one of the largest in the East. The report sets forth the scientific activities of the Survey both in the field and in the laboratory, the papers that were published by the staff in the journals of the Museum and gives a general idea of the working of the Institution. A number of original contributions were made by the staff and research workers of the Survey and were published in the Records and the Memoirs of the Indian Museum and other journals. The recent retrenchment effected in the contribution of the Government to the Survey has crippled its resources considerably and has resulted in seriously hampering the good work that the Survey has been doing.

* * *

*Report of the Building Research Board for the year 1933, H. M. Stationery Office.*—The report comprises a general review of the activities of the Building Research Board during the year 1933 and a detailed account by the Director of Building Research of the progress of numerous investigations that are being carried out at the Building Research Station. Architects, Builders and Surveyors are finding the Annual Reports of the Building Research Board a valuable means of keeping abreast with progress in building research. An important section of the report deals with problems of practical interest submitted to the Station during the year.

* * *

The appointment of Mr. J. C. Fernandes as Agricultural Technicist to the Government of Mozambique, Portuguese East Africa, is announced. He was a student of the Poona Agricultural College, and was Principal of the Government Agricultural School, Sanguem, Goa.

* * *

Mr. R. K. Bhide, Economic Botanist to H. E. H. the Nizam's Government, retired in March 1934 after 6 years of service. He entered the service of the Nizam after retiring as Crop Botanist to the Government of Bombay. His mature experience helped him to organize crop improvement work in Hyderabad along modern lines. He worked primarily on rice and castor. Strains of rice evolved by him are popular and are spreading in the State. In the 1934 Science Congress at Bombay he participated in the Symposium on Plant Genetics contributing a paper on 'Recent Advances in Breeding Castor'. He was a trained artist and a veteran plant-breeder, who retires at 61 years of age to a well-earned rest.

* * *

*Sixth International Congress for Scientific Management.*—The meetings of the Sixth International Congress for Scientific Management, which will take place in London from July 15th to July 20th, 1935, will be held at the Central Hall, Westminster, and in the Halls of the Institution of Civil Engineers and of the Institution of Mechanical Engineers.

It is the purpose of the Congress as a whole to obtain papers and discussion of practical applications of scientific management in all its phases. References to actual technique will relate to specific problems and how they have been met.

Another aim of the organisers of the Congress is to provide opportunities for members to meet, in an informal way, people from other countries interested in the same problems as themselves, and this will be a marked feature of the organisation. The Congress will appeal to all those holding managerial positions in any phase of our national life, but it is a further object of the Congress to arouse a more public interest in the subject of management.

Previous Conferences have been held in Amsterdam (1932), Paris (1929), Rome (1927), Brussels (1925) and Prague (1924), but never before in Britain. More than two thousand members were enrolled for the Paris Congress, and it is expected that at the Conference in London next year this number will be exceeded.

Full particulars in regard to the arrangements for the Congress may be obtained from the Secretary, Sixth International Congress of Scientific Management, 21, Tothill Street, London, S. W. 1 (*The Journal of the Royal Society of Arts*, 1934, **82**, No. 4265).

* * *

*Fourth Silvicultural Conference.*—In the week October 28th to November 3rd a meeting of Forest Officers from all parts of India was held to discuss Silvicultural matters, particularly from the point of view of research. Over thirty delegates were nominated representing all provinces as well as Indian States with extensive forest interests. The last conference was held in 1929 when Kashmir was the only State represented, but this time Travancore, Mysore, Hyderabad (Deccan) and Chamba Tehri also sent delegates. The Agenda were mainly based on those of the last conference, progress made in giving effect to the resolutions then passed being reported and further developments discussed. Important among the items are methods of research in tropical evergreen forests, the significance of local races of species extensively planted such as teak, forest grazing, and the preservation in perpetuity of selected forest areas. Special attention was also given to soil problems and ecological investigations in their bearing on forestry.

* * *

*Presentation of Papers before Scientific Meetings.*—We are quoting below the suggestions made by the Group of Divisional Officers of the American Chemical Society (*Cf.*, *Ind. Eng. Chem.*, *News Edn.*, 1934, **12**, 300) for the effective presentation of papers by authors before scientific meetings convened for the purpose of reporting and discussing research work. Repeated criticisms levelled against the method of preparation of papers are generally valid and it is hoped that by observing the suggestions, the authors would materially assist in improving the scientific value of the meetings.

1. *Arrangement of Material.*—Manuscripts as prepared for publication are seldom suitable for oral presentation. The paper should convey clearly to the hearer: (*a*) the purpose of the work, (*b*) the experimental method, (*c*) the results obtained, and (*d*) conclusions. The nature of the material and the time available for presentation will determine the degree of emphasis to be placed on each sub-division. The author should make certain by trial against his watch that the essential points can be adequately presented in the time allotted to the paper.

2. *Statement of Purpose.*—Orient the audience clearly as to the nature and purpose of the work. A lengthy historical review is generally out of place.

3. *Technique.*—Describe the experimental method employed so as to indicate the principles involved. Omit details of apparatus or procedure unless there is some particularly novel development. Such data may be included in the published paper but will bore your audience.

4. *Statement of Results.*—Present the results graphically, preferably with diagrams. Lantern slides are more clearly seen than hand-drawn charts. These slides should be of standard size (3·25×4 inches) and should project clearly on the screen. Regardless of who has made the charts or slides, try them from the point of view of the audience before presenting them at the meeting. Do not read tables, a procedure which wastes time and destroys interest but point out the general trend of the data.

5. *Conclusions.*—Summarise the evidence and discuss the importance of the results or conclusions to the particular field of research involved.

6. *Manner of Presentation.*—Do not read from a manuscript verbatim. Talk directly to your audience in a clear, loud voice. Do not face blackboard or screen while speaking. Articulate distinctly.

* * *

*The Microid Physical Series.*—Messrs. Griffin & Tatlock, Ltd., with a reputation of over one century as makers of scientific instruments, have recently put on the market a whole range of physical apparatus incorporating several improvements in technique. They are admirably adopted for the demonstration of physical principles, and have aroused keen and wide-spread interest among those who have seen and tested them.

The second edition of their catalogue No. 115 x, illustrates a selection of apparatus suited for demonstrating physical principles which should prove invaluable to progressive educational institutions. Each apparatus is illustrated and described separately and experimental notes are provided. Those interested may address enquiries to their Indian Agents, B5, Clive Buildings, P. O. Box No. 2136, Calcutta.

* * *

*New Carl Zeiss Quartz Spectrograph.*—As a result of many years' experiments Messrs. Zeiss have now put on the market their all-metal Quartz Spectrograph "(Qu) 24". The instrument is of extremely attractive design and completely enclosed. The spectrum can be photographed over the whole range from 2000 Å to 5800 Å, special importance having been attached to good definition of the lines in the region between 2000 Å and the short wave end of the visible spectrum. The total length of spectrum is about 230 mm. on the 24×6 cm. plate. In order to enable scientists in India to examine this spectrograph Messrs. Adair Dutt & Co., Ltd., will, as they inform us, exhibit the instrument during the next Science Congress Exhibition in Calcutta. We do not doubt that a large number of our readers will be interested in this product of a world-renowned firm.

* * *

We acknowledge with thanks the receipt of the following.—

"Actualités Scientifiques et Industrielles," Nos. 134, 137, 142, 161.

"Journal of Agriculture and Livestock in India," Vol. IV, Pt. V.

"Journal of the Annamalai University," Vol. III, No. 2, October 1934.

"The Biochemical Journal," Vol. 28, No. 4.

"American Journal of Botany," Vol. 21, No. 8.

"Journal of the Indian Botanical Society," Vol. 13, No. 2.

"Canadian Journal of Research," Vol. II, Nos. 2 & 3.

"Chemical Age," Vol. 31, Nos. 795—798.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 67, No. 10.

"Experimental Station Record," Vol. 69, Index Number.
"Educational India," Vol. I, No. 4.
"Indian Forester," Vol. LX, No. 11.
"Forschungen und Fortschritte," Jahrgang, 10, Nos. 28—29.
"Indian Forest Records," Vol. 20, No. 11 (Back Numbers Vol. 17, Pts. 1, 9 & 10; Vol. 18, Pts. 1—8, 13).
"Report on Cocoanut Enquiry in India," by Dr. J. S. Patel. Imperial Council of Agricultural Research. (Govt. of India Publication.)
"Medico-Surgical Suggestions," Vol. 3, No. 10.
"Nature," Vol. 134, Nos. 3386—3389.
"Natural History," October 1934.
"Journal of Nutrition," Vol. 8, No. 3.
"Journal of Chemical Physics," Vol. 2, No. 10.
"Records of Indian Museum," Vol. 36, Pt. II. Report on a Collection of Cestodes from Lucknow, by L. N. Johri, Vol. 37. Pt. II, on Termatodes from Wild Ducks in Rangoon, by B. S. Gogate.
"Science Progress," Vol. 29, No. 14.
"Review of Scientific Instruments," Vol. 5, No. 9.
"The Indian Trade Journal," Vol. CXIV, Nos. 1478, 1480.
"Indian Journal of Veterinary Science and Animal Husbandry," Vol. 4, Pt. 3, Sept. 1934.
"Arkiv för Zoologi," Band 26, Häftes, 3 and 4.
"Coffee in 1931 and 1932"—Economic and Technical Aspects. Issued by the International Institute of Agriculture, Rome.
"Forest Research in India, 1933–34," Pt. I. Issued by the Forest Research Institute, Dehra Dun.

## Reviews.

ACTUALITÉS SCIENTIFIQUES ET INDUSTRIELLES. (Hermann et cie, Editeurs; Paris, 1934. Nos. 115, 116, 141 and 162.)

The first three numbers belong to the "Exposés d'Astronomie Stellaire" series and the last to the "Exposés de Physique Moléculaire" series.

1. *No.* (115). *Histoire de l' Astronomie stellaire jusqu'a l' époque contemporaine,* par H. Mineur (pp. 1-57).

This is the first of the series relating to topics on Stellar Astronomy and is meant to be a historical introduction. The author has very wisely confined himself to the statistical portion of Stellar Astronomy dealing with movements and distribution, leaving Stellar Physics to be dealt with under another series. Even with this limitation the subject is so vast that success in presenting a clear and comprehensive exposition must be really considered an achievement. The author who, along with Oort and Lindblad, has done distinguished work on the subject of the rotation of the Galaxy has been eminently successful in presenting such an exposition in the short space of fifty-seven pages. The author's aim has been not to give a mere chronicle of dates or a catalogue of figures but to present "l'état actuel de la science, ses methodes et ses documents". The amount of information contained in and the variety of topics treated by this little book are truly astonishing. The author even finds space to present a clear account of the activities of the I. A. V. and it is interesting to read in this connection that "Dans lesvotes administratifs, chaque pays a un nombre de voix proportionnel à sa population, mais dans les votes sur les questions scientifiques, chaque astronome présent dispose de sa voix".

On account of the vastness and rapid growth of the subject it would naturally be easy to pick out here and there a few topics not treated by the author. It might thus be pointed out that mention is nowhere made in the book of novæ and planetary nebulæ, but perhaps the author thought that these are not of much statistical significance although important from the point of view of stellar evolution according to Milne's theory. In dealing with Shapely's cosmological scheme of supergalaxies and metagalaxies mention could have been made of estimates relating to the size of the galaxy and how the trend of recent work in this connection (see, for example, Plaskett & Pearce, *M.N.R.A.S.*, June 1934) is towards a reversion to Shapley's original ideas. Again, the work of Kapetyn and Strömberg on star streaming is given in bald outline without any attempt at clothing it with the flesh and blood of the relevant theory.

It must be admitted, however, that these are all trivial lacunæ in an otherwise excellent book which is so modern in outlook. The book contains two excellent photographs of Kapetyn and Shapley and other maps locating the important observatories of the world. One would have liked to see also a photograph of Herschel who is justly considered the father of Stellar Astronomy. A striking feature of the book is the original idea of the author of indicating the progress of astronomy during the centuries by means of a number of graphs in which the abscissa are the dates and the ordinates are the logarithms respectively of the number of

catalogued stars, number of proper motions determined, radial velocities, measured parallaxes and known variable stars at each epoch.

2. (*No.* 116). *Éléments de statisque Mathématiques*, par H. Mineur (pp. 1 to 40).

While the previous volume serves as a general introduction to statistical astronomy, the present one is intended to be a sort of mathematical introduction. While there is nothing in this book which would be new to a professional statistician, it is bound to be of the highest value to workers in stellar statistics and in other experimental sciences where mathematical statistics is applied. This is in fact the aim of the book and by the choice of particular examples from astronomical topics like stars of different absolute magnitudes and the correlation between spectral type and absolute magnitude, the author has succeeded in making the subject very intelligible. We only wish that there were more examples of this type especially in the later part of the book dealing with the characteristic function of a law of distribution and the application to integral equations. A specific example, chosen for example, from Searc's work on the density and luminosity functions would have added greatly to the clarity of exposition. The author's remark on the use and abuse of the law of Gauss, *viz.*, "La loi de Gauss ne doit etre utilisée comme un moyen que si elle est applicable an probleme étudié, mais rien *a priori* ne doit faire admettre qu'une loi de repartition inconnue est une loi de Gauss. L'oubli de cette remarque, pourtant si élémentaire, pourrait conduire à des resultats sans valeur" deserves to be widely known. The representation of a distribution by the sum of two Gaussian laws and an application of this to a particular case met with in stellar movements are particularly well treated.

It is perhaps true that the information contained in this book may not be *sufficient* to workers in statistical astronomy, but there is no doubt that it is *necessary* and indispensable.

3. (*No.* 141). *Photographie Stellaire*, par H. Mineur (pp. 1-67).

The two previous numbers of the series were more or less of a general nature; but in this volume the author considers the definite problem of explaining the methods of stellar photography for the determination of the positions and magnitudes of stars. Determination of stellar positions by photography covers less than one-third of the book and contains the usual methods of calculation of the constants of a plate and the reduction to celestial coordinates. There is, in addition, valuable information regarding practical details of stellar photography and stellar images.

The remaining two-thirds of the book dealing with stellar photometry is easily one of the best connected accounts of the subject which the reviewer has seen explained in such a short space. Visual photometry is first dealt with very briefly and includes Pickering's meridian photometry culminating in the Revised Harvard Photometry and mention is also made of several catalogues of visual magnitudes, specially the Bonner Durchmusterung. The fundamental methods of photographic photometry, like the method of comparison with a sequence and other methods depending on the production of stellar images with known difference of magnitudes, are then explained. A study is then made of specially important sequences like the north polar sequence, Kapetyn's selected Areas and the Harvard sequences of Miss Leawitt. Mention is next made of the important photometric catalogues. A very interesting calculation of the limiting magnitude of a star visible in an instrument is given and is perhaps due to the author himself. The book ends with a short account of the method of extrafocal images and the ocular circle.

A rather significant omission noticed is the photometry of nebulæ, galactic and entragalatic. The photometry of extra-galatic nebulæ has received a good deal of attention in recent years principally from the point of view of the integrated magnitudes, visual and stellar. But it is perhaps unfair to ask for more when the author has given so much of excellent and up-to date information. For any one who wants to study stellar photography and "know what it all means" there is no better book that can be recommended. A list of contents and a short index would have added greatly to the value of the book.

4. (*No.* 162). *Travaux récents sur les molécules daus le soleil, les planètes et les Étoiles*, par P. Swings (pp. 1-44).

This book, which belongs to the series of monographs on molecular physics, is a natural sequel to the author's previous book in the Atualité series No. 50 entitled "Les bandes moléculaires dans les spectres stellaires". This appears to be the reason why one does not find here a treatment of the general theory of the subject involving principles

and technique. It consists of a connected account of recent work done in this field mainly between 1932 and 1934 and presents information properly "baked and cooked and served hot from the oven". Molecular bands in the solar spectrum cover four pages, spectra of planets about five pages and the rest is devoted to stars on the main sequence of classes F-G-K-S-M. A very clear account of the work on Carbon stars, specially the work of Rosenfeld and Wurm is given in a separate section. Mention is made in this connection of an interesting application of Schrodinger's wave functions to determine the relative intensities of bands of different groups in the spectra of $C_2$ and CN. The book ends with an exposition of the very recent memoir of H. N. Russel (*Astrophysical Journal*, April 1934, p. 317) on molecules in the sun and the stars. The results of this memoir are compared with the earlier work of Rosenfeld and shown to be an improvement on it.

The book contains a table of contents and a very valuable bibliography. It should be indispensable to workers in this field giving as it does a coherent summary of all the memoirs included in the bibliography.

B. S. M.

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IONS, ELECTRONS AND IONISING RADIATIONS. By J. A. Crowther. (Edward Arnold & Co., London. Sixth Edition, pp. xii+340, 1934.) Price 12*s*. 6*d*. net.

The popularity of this well-known text-book is amply evidenced by the appearance of the sixth edition. Although larger text-books have now appeared, the book still fulfils a want and that well: it provides an introduction to the modern advances in physics that is at once simple, comprehensive and free from abstruse mathematics. The new edition is an improvement upon the last which appeared in 1929: two new chapters on "Neutrons, Positrons and Cosmic Radiation" and "The Structure of the Nucleus" have been added. The value of the book is enhanced by a set of problems at the end. The rest of the book has also been revised and many parts re-written and re-arranged, while a number of sections has been omitted as no longer interesting. Amongst the new information added all controversial points are left out as they ought to be, but the advantage of assuming only neutrons and protons with $\alpha$-particles but no free electrons in the nucleus from the point of view of the mass defect curve might have been described. An account of induced Radioactivity discovered by Curie and Joliot and extensively studied by Fermi and his co-workers might also have been given. Among the excisions we should have liked a few descriptions of experimental work to have been retained such as Langevin's method of finding the mobility of ions, or Townsend's experiments on the determination of the electronic charge, since they are instructive and interesting from a historical point of view. Apart from these minor details, the book in its new form gives an up-to-date account of most of the important fields of modern physical research and may be warmly recommended to all those who are beginning a serious study of modern physics after a tolerably good acquaintance with classical physics.

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PERKIN AND KIPPING'S ORGANIC CHEMISTRY. Parts I, II and III. By F. S. Kipping and F. B. Kipping. (W. and R. Chambers, London.) Parts I and II in one volume, 614 pp. reprinted in 1933. Price 8*s*. 6*d*. Part III separate volume 615–967 pp. 1st edition 1934. Price 6*s*.

Parts I and II deal mainly with general systematic organic chemistry maintaining throughout a careful balance between theory and practice. The presentation and the scope of the subject are admirably adapted to serve as a very useful text-book for students preparing for a pass degree examination. Some of the subject-matter in small type and also the chapters XXXVII–XL as suggested by the authors are to be omitted from the pass degree course. The volume gives in detail the preparation of about eighty compounds many of which are ordinarily prepared by students during their course of practical work and as such avoids the necessity for buying a separate text-book of practical organic chemistry. The numerous editions undergone by this text-book during the past forty years speak for its continued popularity as an admirably adapted text-book. However, for students preparing for an Honours degree the matter is inadequate and necessitates supplementation. The authors will do well to adapt these two parts for pass course only and for such an adaptation the following alterations are suggested:—The Chapters XXXVI to XXXIX both inclusive might be condensed into one chapter under the heading 'Important components of animals and plants' and treat in a very elementary

manner alkaloids, terpenes, proteins, purine derivatives, pigments, vitamins, etc., so that the student can have just an idea of the scope and importance of the subject. The chapter on dyestuffs also is to be recast so as to give the student a mere outline of the nature and types of dyes and their variation in colour with structure.

Part III which is recently written as a continuation of Parts I and II is intended mainly for students preparing for Honours degree examination. This part which deals with special and advanced topics like stereochemistry, electronic formulæ of organic compounds, terpenes, carbohydrates, etc., gives a very good description including the recent and up-to-date investigations. However, as it stands the part is inadequate for the standard for which it is intended. To make the volume a really useful text-book for Honours course the authors will do well to effect the following changes. This volume may be divided into two parts the first dealing with general organic chemistry and the second with Natural products. Then the Chapters XLI—L and LVII—LXI will have to be included in Part I. Heterocyclic compounds are to be elaborated and chapters on synthetic dyes and drugs added. Part II will then include Chapters LI—LVI. The Chapter LVI is to be treated in a more elaborate manner under different heads, *e.g.*, Plant Pigments, Vitamins, Hormones, Proteins, etc. Chapters on alkaloids and purine derivatives are to be added. With these alterations this volume becomes a very useful text-book for Honours course.

H. S. J.

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NITROCELLULOSE ESTER LACQUERS: THEIR COMPOSITION, APPLICATION AND USES. By Dr. Fritz Zimmer. Translated by H. K. Cameron. B.Sc., Ph.D., F.I.C. (Chapman & Hall. 246 pp.) Price 18*s*.

Judging by the present state of Chemical Industry in India, it is doubtful if the production of modern Nitrocellulose Ester Lacquers will ever become a problem to her technical men; but their application and uses are, as indicated in the book, so wide and growing so rapidly even in this country, that its study will greatly help the technician.

The author is the chief chemist and technical director of a large paint works in Germany with a quarter of a century of experience in the field and has, as pointed out by the translator, produced an essentially practical book. It is difficult to think of any work which gives such a condensed and vast amount of detailed-technical information on the production, application and uses of the material described, namely, nitrocellulose ester lacquers. The manufacture of nitrocellulose, the properties of solvents, diluents, plasticisers, gums and resins and pigments which go to make the finished lacquer are all dealt with in sequence and with thoroughness. The method of application and the various uses to which they may be put are indicated. A description of plant used in the manufacture of the lacquer and various appliances used in their application are also included.

It would be ungrateful to complain where so much that is good has been offered; but a comparative estimate of cellulose acetate lacquers could well have been included. An error in the structural formula of diacetone alcohol on p. 21 may also be corrected in a future edition.

The publishers and the translator deserve to be thanked for putting such a valuable book in the hands of the English-reading public.

M. RAJAGOPALAN.

## Errata.

Vol. III, No. 4.

Page 153, column 2, line 6 from bottom, *read* "The Band Systems of CaCl" *for* "The Band Systems of $CaCl_2$".

Page 154, column 1, line 4, *read* "CaCl" *for* "$CaCl_2$".

Page 159, referring to the magnifications under the figures 4, 5, 6, 7, 8, 9, 10, 11 and 12.

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| *read* | ×620 | *for* | ×310 |
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1990-34.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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CONTENTS.





# Inland Fisheries in India.

THE *Statesman* of Calcutta recently published a series of short articles on "Fisheries of the Punjab" contributed by a correspondent. These articles disclose an inside knowledge of the working of the Department of Fisheries in the Punjab, and raise certain problems of such fundamental importance in regard to its administration and scientific aspects, that we think it necessary in the interests of the fishing industry to invite public attention to them.

Some twenty years ago when the Punjab Government organised the Fisheries Department, Mr. G. C. L. Howell, I.C.S., was placed in charge of its destinies. This appointment was in general conformity with the doctrine which all the governments used fondly to entertain (on the basis of the principles of facultative psychology), that a member of Civil Service is good enough for every conceivable branch of administration. The reason why a civilian is not appointed as head of the Cavendish Laboratory may, however, be found in the fact that it is not an earning department and its output is not immediately taxable. But in all industrial concerns where a deep scientific knowledge and technical training are indispensable for efficient and successful management of their affairs, Government assumes that the administrative experience of its officers is more than their equivalent. It is true that the general administrative officers possess alertness of mind, a comprehensive vision, tact, ability and application, but neither any one of these qualities nor all of them together will avail in the management of departments in which an intensive scientific training, technical experience, acquaintance with the methods of research and ability to initiate original investigations are required for making the concern a remunerative one; knowledge of revenue collection and of the penal code must, at all times, be a poor substitute for these qualities. The administrative duties in the fishery and agricultural departments are considerable and responsible, and it seems to us that the head of such departments must also be a research worker himself so as to be able to guide the laboratory work of his assistants, to assess their results and suggest problems for fresh investigations. Moreover, the administrative functions of

scientific departments are not identical with those of the general branches of government, and a blank mind, which is not often the supreme qualification of even a judicial officer, can never be an equipment for scientific posts. The prevailing practice of appointing civil officers as heads of technical and scientific departments is due to the fact that Government, which expends money on their organisation, desires to control their output, and no one is more competent to advise Government on the subject of prices and taxation than its civil servants. An industry, whose scientific problems are subjected to considerations of prices and taxation, must ultimately become as inefficient as an industry that has no scientific problems. An industry without a civilian head to control its affairs is as blessed as a country which has no history.

The correspondent of the *Statesman* suggests in the concluding portion of his contribution that the research work on Fisheries in the Punjab should be closed down "until such time as adequate funds are available to place it on a proper footing, with a pisciculturist from Europe or America at its head". This is just the kind of advice that a civilian administrator of scientific departments would, in a spirit of despair, tender to the government when its financial resources might temporarily be dislocated: but the viewpoint of a scientist would precisely be the opposite. A time of economic depression is manifestly the psychological moment for the display of financial courage and technical skill, for if the lines of scientific investigation in the government industrial departments have been carefully planned with reference to the experimental and other environmental conditions, then it would be realised that the only protection against depression is more research. If the major industries such as agriculture,—and under their category we would also include pisciculture,—are ultimately to be depended upon for the restoration of financial stability, then the suggestion for the curtailment of research, even as a provisional measure, would appear to be fatal to the best interests of government. We have had occasion (*Curr. Sci.*, Oct. 1933) to comment on the subject of research on Fishery work while reviewing Mr. Sorley's report on the Marine Fisheries of the Bombay Presidency, and we would repeat once more that if research work is entrusted to competent persons, then government will find it profitable to invest more funds in its promotion. The prosperity of any industrial organisation must depend upon continuous and anticipatory scientific research, and industrial prosperity implies the financial stability of government. In the existing scheme of competitive internationalism, the advocacy of the policy of closing down research departments of government industries, such as is advocated by the correspondent of the *Statesman* and Mr. Sorley, can only be accepted on the responsibility of placing the country in a state of perpetual dependence on foreign products.

The second proposal made by the correspondent, *viz.*, that a European or an American pisciculturist ought to be appointed as head of the fisheries department in the Punjab betrays his ignorance on the subject of fisheries research in India. An American or European pisciculturist may be a very eminent scientist in his own country, but in the widely different conditions prevailing in the tropics, he will generally find that he has to unlearn a great part of his training and experience before he can understand the complicated situation arising from the vagaries of the dry Indian climate, the rainfalls which obey no known law, the little understood habits of fishes which still have to be studied more intimately, the diverse customs and practices of the country, the nature of the rivers and tanks and the uses made of their waters for irrigational purposes. In the case of all appointments of foreign scientists, a more or less prolonged period of self-education in the complicated and unfamiliar local conditions must necessarily precede the acquisition of anything like a clear grasp of the situation and the nature of Indian problems. If these scientists are really capable men, they may begin to gather experience of fishery work in the tropics during the probationary period and start on some useful lines of scientific investigation, otherwise they drift into the administrative branches of their department. In fact, it has been a singular misfortune of the Fishery Researches in India that, after Francis Day, persons, without competent knowledge and experience of the peculiar local conditions, have been appointed in most of the provinces, with the result that their efforts have been always unsatisfactory. So far in the Punjab there have been two directors of the department, but neither

of them could claim to possess any scientific training or previous experience of fishery work, and accordingly they attended only to the administrative aspect of their work to the detriment of the more important side of scientific enquiries. The department needs the scientific atmosphere and inspiration for the junior workers, and they can be provided only by the unbounded zeal of the head of the department who must be an intrepid research worker himself.

The Department of Fisheries in the Punjab at the time it was established set out to achieve a three-fold object, *viz.*, to conserve all the species of fish then held by the rivers and tanks through regulation of the methods of fishing and the abolition of uneconomic and wasteful devices adopted by the fishermen; to discover the habits and life-histories of the more important forms with a view to breeding them in captivity; and to attend to the interests of the fishermen castes and to bring back many to the trades of their forefathers. These are simple propositions and of these the second only is scientific, capable of being accomplished by a steady pursuit of the subject. According to the correspondent of the *Statesman* when a research officer was appointed in 1920, "it was confidently hoped that this branch would develop, but fourteen years have elapsed and except that he has been accommodated where he has access to a fine laboratory, research as such is no further advanced." The research officer alluded to is a young inexperienced graduate of the Punjab University, and he was expected to work miracles, without special training and necessary guidance by the head of the department. If the Fisheries Department of the Punjab was unable to discover the general habits and life-history of the carp (*Labeo rohita*) in order to stock the rivers of the province, the blame attaches to the defective planning of the department. We have no hesitation in maintaining that the official head of the department must be a scientist, possessing competent knowledge and training and capable of conducting original investigations himself and directing those of his subordinates. The post ought not to be offered to civilians whose interest in the development of the scientific sections cannot be expected to be more than academic; and it is uncharitable to require them to guide researches for which they possess neither adequate knowledge nor previous training.

According to the testimony of the writer in the *Statesman* the Fisheries Department has achieved a certain measure of success in reclaiming those fishermen whom the system of *begar* (labour for government servants without remuneration) had driven to basket-making. This is certainly a great departmental achievement. But it must be remembered that the system of *begar*, in any event, is bound to become obsolete on account of the spread of education and the growth of political consciousness. Will the suppression of unremunerated labour by official authority and police vigilance keep the fishermen to the profession of their forefathers? The reports of the Bombay and Madras Fisheries departments deplore the increasing tendency of fishermen to take to more lucrative professions in considerable numbers, and this is only part of the universal phenomenon of the defection of industrial communities from their traditional occupations. This is due to two causes. In the first place the doctrine of proportional representation in government appointments and local bodies and legislative chambers has stimulated the competitive ambitions of every section of population to acquire and exercise political and administrative authority. Perhaps, the second cause must be the discovery, that the education that is imparted to the children of the industrial people, has no relation to their occupational activities, but tends only to produce a decided aversion for them. More than all these, the rapid industrialisation of the urban areas must, by the offer of higher wages, deplete the villages, whose population once drawn into the welter of distractions of the cities is permanently lost to rural occupations. Fishermen are not saints. To enable them to pursue their traditional profession in happiness, peace and contentment, to make them realise that an intensive and scientific cultivation of their industry will bring them increasing prosperity and political power, and to induce them to take a legitimate pride in their descent from Peter and John, are problems of such magnitude and importance that, in the successful solution of at least some of them, the head of the Punjab Fisheries Department might reasonably take pride, but assuredly not in the suppression of the *begar* system.

Regarding the scientific work of the

Fisheries Department we read in the *Statesman* that "efforts to breed the indigenous fish of the country ended in a failure" and the next paragraph opens with the sentence "the only direction in which the department could point to with some pride was the introduction of the trout". If the cultivation of this foreign species is thriving in the streams of the Punjab Hills, the department is, however, unable to account for its success. Besides, an act of this nature, manifestly undertaken in a playful mood to gratify a whimsical curiosity, but not based on scientific prescience, is fraught with intricate and numerous biological consequences. In Madras the experiment of trout breeding is proceeding, and the effects of successful cultivation of foreign species on the population of indigenous forms must be carefully watched. In our existing incomplete knowledge of the feeding and breeding habits of many of the local forms of fish, the introduction of foreign fish into their midst might possibly disturb the balance of life, and lead to the rapid diminution and ultimate extinction of the former. Any interference with the delicate adjustment of life in restricted areas by clumsy experiments, which are usually attended by disastrous results, is an act which few trained and experienced scientists would lightly undertake, and palpably it must be in the nature of a speculative adventure.

The suggestions made by the correspondent in regard to the establishment of sanctuaries for the propagation of indigenous fish deserve immediate public attention and comments were made on this subject in *Current Science* (*vide* issue for July 1933). In the Punjab with its network of rivers and canals, facilities for the creation of a number of sanctuaries exist, and the delay in the formulation of a scientific scheme for conservation and propagation of fish is unaccountable. The utilisation of river and tank waters largely for irrigation purposes must unfortunately have an adverse effect on the general habits of fishes, and in all irrigation projects, due attention should be paid to the needs of the fishery of the country. Dr. Francis Day has made valuable suggestions on this subject in his Reports on Fish and Fisheries of India, which are available to the heads of the Fisheries Department for consultation, and we have no doubt that many of them can, with a slight improvement, be adopted to suit the particular circumstances of the provinces.

In his last note, the correspondent deplores the fact that "on the retirement of the late Warden the post was abolished and Fisheries Department was placed directly under the Director of Agriculture as a separate entity." It is to be remembered that in every civilised country, a combined Ministry of Agriculture and Fishery has been found to be a great advantage both as a measure of securing economy and unitary administrative control over the two industries, whose problems cross one another in several ways. In India the political divisions, especially in the older Presidencies like Bombay and Madras, are far too extensive and varied in geographical features, to be brought under a unitary scientific or administrative control. In Madras where a few years ago, higher education used to be directed by a single University, it is now under the management of five or six universities, and we think that it would be advantageous to split each of the larger presidencies into at least two divisions for the purposes of developing the Agricultural and Fishery Departments. The first step in this much-needed decentralisation is to separate Marine Fisheries from Inland Fisheries. The latter is to be divided into two departments in conformity with a similar bifurcation of the Agricultural Department. They should then be put in administrative charge of one Director for each of the divisions, and the two departments should be provided with a separate well-equipped laboratory under competent scientific staff. For the purpose of co-ordinating the results and the initiation of new problems in pisciculture, the creation of a new Central Bureau of Fishery Research under the control of the Member of the Department of Education, Land and Public Health, becomes a matter of imperative necessity. Our considered opinion is that the establishment of this central scientific organisation is overdue. Early in September, the Advisory Board of the Imperial Council of Agricultural Research held a prolonged discussion on the conditions of the Fisheries industry and the possibility of its development. It was generally agreed that there was great need for the appointment of an expert committee to investigate the question in all its aspects, and it was announced in the papers that the Fisheries Committee would soon be instituted. It is

hoped that the terms of reference to the Committee, when established, will be sufficiently wide and elastic, so as to permit an exhaustive enquiry being undertaken. Those who have actually done research on fish and fisheries in India are few, and we have no doubt that the wealth of knowledge and experience accumulated by individual scientists will be found invaluable in conducting the enquiry by the Committee. We confidently hope that sufficient room will be found for experts on this proposed Committee whose proceedings will be followed with earnestness by the public, whose interest in the development of the food resources of the country is manifestly increasing.

# Some Recent Advances in Indian Geology.*

By W. D. West,
*Geological Survey of India.*

## 3. The Geology of the Himalaya.

DURING the past ten years or so considerable progress has been made in our knowledge of the geology of the Himalaya, which has only served to show how complicated is the geology of this great range and how great is our ignorance of its real structure. During this period work by the Geological Survey of India has mainly been concentrated in two areas, the North-West Himalaya in Hazara and Kashmir, and the Simla hills around Simla and Chakrata; while in addition there have been several foreign expeditions to the Karakoram and neighbouring tracts beyond the Himalaya which have added something to our knowledge of the geology of those parts. Thus in spite of large blanks still existing on the geological map of the Himalaya, largely accounted for by the inaccessibility of Nepal, the accumulating results of steady mapping are gradually providing a sure foundation on which may ultimately be built a complete synthesis of Himalayan geology. Theories of mountain structure based on our present incomplete knowledge of even one section of the Himalaya must necessarily be largely speculative. They arrive almost by every mail, and are frequently advanced by those whose acquaintance with Himalayan geology is by no means extensive. Perhaps of no part of Indian geology can one more truly say that the more one knows of it the more one realises how little one knows. The present policy of the Geological Survey is to concentrate its small available resources on two sections of the Himalaya, as stated above, in the belief that a sustained attack on these two selected areas will yield more valuable knowledge of the geological structure of the Himalaya as a whole than a larger number of smaller investigations spread over a wider area. The summary that follows, therefore, deals mostly with these two areas. In compiling it the writer is indebted to his colleague Mr. J. B. Auden for many fruitful discussions on the problems raised therein.

### THE NORTH-WEST HIMALAYA.

The most striking feature in the orogeny of the North-West Himalaya is the way the strike of the mountains, after following an arcuate S.E.—N.W. direction for over 1,200 miles from Assam to Kashmir, makes a great bend in Hazara, rapidly curving round through an E.—W. to a N.—S. direction, and producing thereby a great re-entrant angle in the alignment of the mountains between Abbottabad on the South-West and the Kashmir valley on the North-East. This bend is seen not only in the frontal ranges bordering the Indo-Gangetic alluvium, but is repeated in each successive range northwards, culminating in the Pamir massif. Even this great mass shows the same trend lines, which are south-west on the west, equatorial through the Pamirs, and south-east on the east side, as first determined by D. L. Ivanow and subsequently confirmed by Sir Henry Hayden.[1] As regards the origin of this feature, it had previously been supposed by E. Suess in his great work 'Das Antlitz der Erde' that the rapid change in the strike of the mountains was due to the meeting at an oblique angle of two mountain systems, the Himalaya and the Hindu Kush.[2] For this line of meeting

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[1] *Rec. Geol. Surv. Ind.*, 1916, **45**, 271.

[2] *The Face of the Earth*, 1904, **1**, 422.

Suess used the term 'schaarung', which was translated by Sollas as 'syntaxis'. The following quotation from the English edition gives his conclusions:

"Like two shallow streams of lava, or two flows of slag running side by side, the waves of which as they cool come into syntaxis against a long line, now fusing completely together, now encroaching on one another, so the chains of the Himalaya meet those of the Hindu Kush."

He especially emphasised, however, the essential unity of the movements, and the unity of structure of the whole. Quite recently D. N. Wadia's work in the more southern portion of this syntaxial area has shown that both from a structural as well as from a stratigraphical point of view there is a complete continuity of Himalayan geology around this re-entrant, at any rate on its southern border, the structure and stratigraphy on the Hazara side of the syntaxis being the mirror image of the structure and stratigraphy on the Kashmir side. as originally pointed out by Middlemiss.[3] Instead, therefore, of two directions of mountain movement having converged upon Hazara, the Hindu Kush from the north-west and the Himalaya from the north-east, as envisaged by Suess, Wadia concludes that there has been a single Himalayan movement from the north which has come up against some underground obstacle around which it has been forced to diverge. It is suggested by him that a tongue of the ancient and stable peninsular rocks extends upto the north-west beneath a covering of Kainozoic rocks, and that this has formed the obstacle to the folding movement coming from the north, so that the original north and south direction of movement has been resolved into a N.E.—S.W. direction in Kashmir, and a N.W.—S.E. direction in Hazara. There still, however, remains the difficulty of explaining how the W.S.W. to E.N.E. direction of overthrust which is found on the south-west side of the syntaxis, in the neighbourhood of Garhi Habibulla, can have originated in a movement coming from the north. This latter problém was discussed briefly by J. W. Gregory, who suggested that the older supposed 'Altaid' mass of the Safed Koh in the country west of Peshawar may have been responsible for this backward movement.[4] Recently D. Muschketoff has suggested that this 'Jhelum wedge', as he calls the underground obstacle, has been a tectonic feature of importance since Caledonian times, and has been responsible for a number of abnormalities such as the N.N.W.—S.S.E. direction of the Ferghana range, which although of Kainozoic age runs at right angles to the main Himalayan trend lines on either side.[5] A complete understanding of the origin of this great orogenic feature will probably have to await further information concerning the structure of the Hindu Kush, the Karakoram, the Pamirs, and the country north of the Pamirs.

In that part of the syntaxial area investigated by Wadia, three structural elements are defined: (1) a 'foreland' consisting of a great thickness of moderately folded Murree (Miocene) rocks, overlying the supposed tongue of Peninsular India; (2) a belt of autochthonous rocks thrust (the Murree thrust) against the foreland of Murrees, comprising rocks ranging in age from Carboniferous to Eocene, but consisting essentially of a recumbent fold of Eocene rocks, with a core of Panjal trap; and (3) a 'nappe' zone of central Himalayan rocks, which has travelled far along a nearly horizontal thrust plane (the Panjal thrust), so as to lie with marked discordance sometimes upon the rocks of the autochthonous zone and sometimes directly on the rocks of the foreland. This Kashmir 'nappe', as Wadia calls it, is composed, in the syntaxial area, mostly of Dogra (=Attock) slates and the Salkhala series (=Jutogh series of the Simla hills). The former are thought to be lowest Cambrian or older, and the latter Archæan (see table below), the whole 'nappe' being the oldest part of the Himalayan geosyncline which has been overfolded and travelled along a thrust plane many miles from its original place of deposition. To the east of the syntaxial area, and lying upon the top of the 'nappe' in the form of a synclinal basin, and forming the Shamsh Abari mountains, there occurs a thick sequence of Palæozoic rocks, including Lower Palæozoic, Devonian (Muth quartzite), Panjal volcanic rocks and Trias. The well-known Kashmir basin of sedimentary rocks occupies a very similar position further east. In his most recent paper Wadia has described the sequence in this north-west part of Kashmir

[3] *Rec. Geol. Surv. Ind.*, 1931, **65**, 189 and *op. cit.*, 1911, **41**, 136-7.

[4] *The Structure of Asia*, 1929, 12.

[5] *Sixteenth Internat. Geol. Congr. Wash.*, Abstract of Papers, 1933.

State.[6] It differs from the sequence worked out by Middlemiss in south-east Kashmir in two ways: (1) it shows a full development of the Cambrian with a good trilobite fauna; (2) it includes an extensive mid-Palæozoic unconformity, there being a gap between the top of the Silurian and the middle of the Carboniferous, which is not found in the rest of Kashmir or in Spiti. This new work is also of interest in showing a passage from the unfossiliferous slate series up into beds bearing annelids and other organic remains, and of these up into beds containing trilobites and brachiopods of Middle Cambrian affinities. According to F. R. C. Reed, "nearly all the species are new, while there is little resemblance to the faunas of corresponding age in the Central Himalaya or northern China. . . . The Cambrian of the Salt range has quite a different assemblage of fossils." It seems likely, therefore, that the Dogra Slates, which underlie these beds, are lower Cambrian or Purana in age. But until fossils have been found in actual Attock, Dogra, or Simla Slates, the age of these rocks must remain in doubt.

Before leaving this area mention must be made of the finding by Wadia of scratched boulders in the Tanakki conglomerate near Abbottabad, where it underlies the Infra-Trias limestone.[7] This find, together with his further observation that the Infra-Trias limestone is interbedded with the Agglomeratic Slate in North Hazara, adds further strength to the contention, first made by R. D. Oldham, that this conglomerate or boulder bed is homotaxial with the Talchir glacial boulder bed, and therefore Upper Carboniferous in age.[8]

An important paper recently published on the geology of Kashmir deals with the researches of C. S. Middlemiss and H. S. Bion on the Agglomeratic Slate series and the Panjal Trap, work that was in progress at the time of the outbreak of the Great War.[9] The Agglomeratic Slate series occurs lying immediately below the great series of bedded basic lavas known as the Panjal Trap, up into which it appears to pass by interbedding. These two series, over most of the area, keep to an horizon between the Middle Carboniferous and the Permian, that is to say at the junction of the Dravidian and Aryan groups, a datum line of great importance in Indian geology, though these limits do not hold good everywhere. Previously found to be destitute of organic remains, the Agglomeratic Slate has been found by these two investigators to be fossiliferous in a few places. To quote from their memoir:

> "This temporarily overlooked fauna is of much intrinsic interest, some of it being new to Himalayan geology and helping to bridge the gap between the middle part of the Carboniferous (as represented by the Fenestella shales) and the Permian which immediately overlies the Panjal volcanics at most points—a gap that had been assumed previously to have been wholly given over to vulcanicity in this region."

As regards the mode of origin of this series, Middlemiss suggested that either it was the product of explosive volcanic action, preparatory to the outpouring of the Panjal Traps, or it was due to ice action, the beds thus being homotaxial with the Talchir beds of peninsular India. He was inclined to favour the first hypothesis. Another peculiar point which puzzled Middlemiss and Bion is clearly brought out by them in this paper, namely, that the Agglomeratic Slate and the Panjal Trap together exhibit in certain areas a very inconstant horizon. Thus the lowest horizon at which the Agglomeratic Slate appears in different sections is very variable, ranging from Middle Carboniferous (Moscovian) to the top of the Uralian. The top of the Panjal Trap shows an even greater variability, ranging from just below the Gangomopteris beds up to the base of the Upper Trias. Thus the total length of time during which vulcanicity occurred in one place or another was from the Middle Carboniferous to the close of the Middle Trias, an immense period of time, queerly contrasted with certain areas where it was restricted to the limits of the Permian only. Further peculiarities noted by these workers included two thick lenticular bands of Triassic limestone interbedded with the Panjal Trap, one of which was surrounded on all sides by trap. The total of these observations led Middlemiss to consider whether the Panjal Traps were not lava flows but intrusive sills, and therefore later in age than the base of the Upper Trias. He even suggests the possibility of their being contemporaneous with the great outpouring of similar basic lavas in peninsular India known as the Deccan Trap, which commenced at the close of the Mesozoic. More recent work by D. N. Wadia on the Pir Panjal range, which borders Kashmir on the

6 *Rec. Geol. Surv. Ind.*, 1929, **68**, 121.
7 *Op. cit.*, 1929, **62**, 153.
8 *Op. cit.*, 1930, **63**, 130.
9 *Pal. Ind.*, N. S., 1928, **12**.

south, has shown that the Agglomeratic Slate series is undeniably volcanic in origin, as is clear from the presence of unaltered as well as devitrified glass in one or two specimens, in which are embedded phenocrysts of orthoclase, plagioclase and quartz.[10] That the greater part of the Panjal Trap consists of sub-ærial lava flows is also concluded by Wadia; and the problems indicated by Middlemiss and Bion, referred to above, do not appear to affect the main conclusions, and may be of only local significance, though they still require solution. As regards its composition, the Panjal Trap is shown by Wadia to consist of abundant flows of basalt, which are generally epidotised to give the familiar bright green colour of these rocks. In places their total thickness is over 5,000 feet. Recently it has been pointed out by K. K. Mathur and S. N. Wakhaloo that volcanic rocks of a more acid type, approaching to rhyolites, are also to be found in this series, being abundant in the vicinity of Srinagar.[11]

While referring to this part of the Himalaya it is convenient to record here that Lydekker's view that the axis of the Pir Panjal is composed of granite has been shown by Middlemiss and Wadia to be incorrect.[12] The greater part of the summit zone is composed either of Panjal Trap or the Agglomeratic Slate series, with small outcrops of Gondwanas.

The Great Himalaya range is generally regarded by geographers, and rightly so, as ending at the Indus, where the great mass of Nanga Parbat dominates everything. Further north-west, beyond the Indus, there are no great heights to suggest its continuation in that direction. Geologically speaking, however, it is continued round the hairpin bend of the Punjab re-entrant into North-East Hazara, as shown by Wadia, and it is probably correct to regard it as terminating, in a geological sense, near Garhi Habibulla, north-east of Abbottabad, where the last of the Salkhala series, belonging to the Central Himalayan zone, are seen. The geology of Nanga Parbat and the adjoining country has recently been described by D. N. Wadia, who shows it to consist of four main elements.[13] These are: (1) para-gneisses, greatly intruded by gneissose granite ('central gneiss' type); (2) the Pre-Cambrian Salkhala series; (3) a mixed zone situated between (1) and (2), consisting of Salkhala series penetrated by gneiss; and (4) great masses of intrusive dolerite and epidiorite. Nanga Parbat itself consists of (1). Wadia was naturally unable to examine the rocks of the main peak itself. But from the evidence of boulders in moraines he thought it was probably composed of gneissose granite. But Dr. P. Misch, who accompanied this year's expedition to Nanga Parbat, states that the mountain is composed entirely of group (1) as given above. The dolerites and epidiorites are regarded by Wadia as genetically connected with the Panjal Trap lava flows, of which they are the hypabyssal phase. In addition to the gneissose granite or 'central gneiss' of Stoliczka, there is a younger hornblende-granite which is post-Panjal Trap in age.

ASSOCIATED RANGES TO THE NORTH.

Coming now to that region of the Himalaya and beyond which has of late been investigated by a number of foreign expeditions, the facts at our disposal are very much fewer, and it is difficult to be certain of the age and mutual relations of some of these ranges. This, added to the fact that geographers and geologists seem to take a different view of what is meant by a range, makes the correct interpretation of a number of isolated observations a matter of some difficulty. Moreover, the country covered by these expeditions does not strictly come within the Himalayan area. Certain points, however, may be referred to, which are of interest to the student of the Himalaya. As has already been pointed out, the Pamirs are to be regarded as the culmination northwards of the great Punjab re-entrant. And since both it and the associated ranges on either side, and the Hindu Kush and the Karakoram further south, conform to the trend lines of this re-entrant, it is natural to expect these mountain ranges to be of Himalayan origin, at least in part. North of the Pamirs the same trend lines are no longer evident. But until a great deal more is known of these mountains, and any older structures which they may show differentiated from their later Himalayan

[10] *Mem. Geol. Surv. Ind.*, 1928, **51**, 238–242.

[11] *Curr. Sci.*, 1933, **2**, 126. Since writing the above Mr. Wadia has informed me that in his opinion these rocks are in the main ordinary Panjal Trap which has been silicified, and not true acid volcanic rocks.

[12] *Rec. Geol. Surv. Ind.*, 1911, **41**, 134; and *Mem. Geol. Surv. Ind.*, 1928, **51**, 223.

[13] *Rec. Geol. Surv. Ind.*, 1932, **66**, 212.

structure, it is best not to be too dogmatic. As regards the relations between the Himalaya and its associated ranges up to the Karakoram on the one hand, and the Kun Lun, the Tian Shan and other ranges to the north on the other hand, it has generally been accepted by geologists, following Suess, that the former group are Kainozoic in age, belonging to Suess's 'Alpides', and the latter of Hercynian age, belonging to his 'Altaids'. E. Argand, however, in his attempted synthesis of Asiatic tectonics, regards the whole as essentially Alpine, any pre-existing 'Altaid' structures having in his view been destroyed in the great Alpine paroxysm.[14] Argand, however, has been proved to be wrong in so many of his conclusions, as for example in Persia, that we may well hesitate before accepting his ideas. According to the more recent field work of E. Trinkler and H. de Terra in the Karakoram and the West Kun Lun, the Karakoram ranges are regarded as Hercynian in age, while their present Himalayan features are attributed to later epeirogenic movements accompanied by extensive faulting.[15] They would therefore group the Karakoram with the Kun Lun in being structurally Palæozoic mountains. In writing of the granite core of the Karakoram, de Terra remarks on the fact that it is underlain everywhere by crystalline rocks, and suggests that the granite has been thrust by mountain making processes over different formations. In this it closely resembles the behaviour of much of the central Himalayan gneissose-granite and its associated crystalline rocks, which appear in so many places to be thrust over the underlying rocks, a problem which is referred to again below. The old controversy as to the course of the Karakoram east of longitude 78° seems to be settling itself as our knowledge of the geography and geology of these areas progresses, and there can now be little doubt that the Karakoram extend E.S.E. and E. right on into the Tibetan plateau.

### THE HIMALAYAN ARC.

In all these discussions it is generally assumed that Gondwanaland played a passive rôle, and that it was the southward move of the rest of Asia against Gondwanaland which buckled up the soft marine deposits of the Tethys, and caused them to be thrust over the edge of Gondwanaland, which to some extent broke along its northern border. But it is of course equally conceivable that it was Gondwanaland which moved against Asia, crumpling up the rocks of the Tethys, and underthrusting itself beneath them. The writer has always failed to understand how one can expect to decide whether Asia moved south and over Gondwanaland, or whether Gondwanaland moved north and under Asia, by observing the structure of the country along the line of thrusting, though others appear to think it possible.[16] There is, however, one line of reasoning which seems to throw light on this problem, and that involves a consideration of the position of Asia with respect to the rest of the world before and after the movement. This point of view has been developed by P. Lake, who, in a paper on island arcs and mountain building, has drawn attention to the fact that the well-known arcs off the Pacific coast of Asia, the East Indian arc through Sumatra and Java, the Himalayan arc, and the Iranian arc of Persia, which are all of Kainozoic age, all have their convex side facing away from Asia, the Pacific arcs facing east, and the others facing south or south-west.[17] We are thus required to explain how a single Asiatic mass can have moved along its eastern border towards the Pacific and at the same time along its southern border towards the Indian Ocean. As Lake points out, a movement of the mass as a whole in both directions does not seem possible, but underthrusting of the ocean-floor from both sides is conceivable, and is, in fact, a necessary consequence of the contraction theory or of Joly's theory. This view receives additional support from a consideration of the central Asian mass itself. Had the earth's crust spread outwards radially from central Asia, we should expect to find a deficiency of matter at the centre of the continent, as Burrard has pointed out.[18] But in fact the reverse is the case, and there is an excess of mass protruding above the spheroidal surface which has nothing to equal it elsewhere on the globe. Consequently the alternative hypothesis, that there has been a general pressure acting

[14] *La Tectonique de L'Asie*, 1924.

[15] *Geologische Porschungen im Westlichen Kun Lun und Karakoram-Himalaya*, 1932.

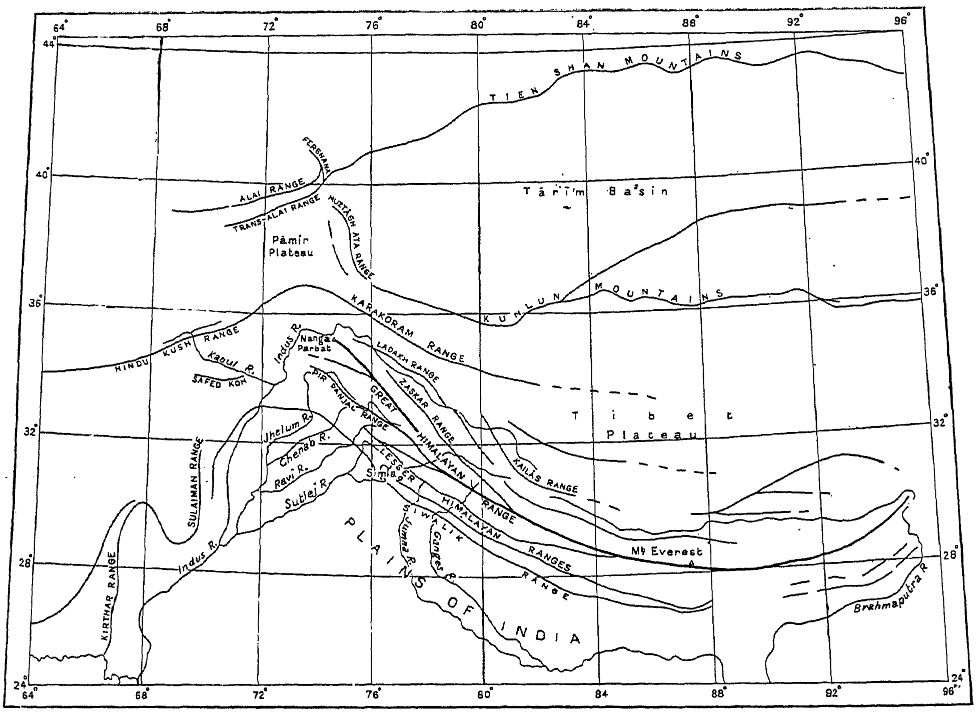
[16] N. E. Odell, *Geogr. Journ.*, 1931, **78**, 159.

[17] *Loc. cit.*, 149.

[18] *A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*, 2nd Edn., 1934, 77.

towards central Asia, seems to be the more acceptable.

The further suggestion developed by Lake in this same paper, that all mountain arcs which have the shape of an arc of a circle, have been formed by movement of a slice of the earth's crust along a single basal thrust plane, and in particular its application to the Himalaya, is one which, in spite of (or because of) its simplicity, is not in accord with the observed facts. Although the Himalayan arc can be shown to be part of a circle, with its pole in Central Asia, it must be remembered that, geologically shown by Wadia in the Punjab re-entrant, there is a continuity of geological structure around this feature which forbids one to bring the Himalaya (geologically considered) to an end at Nanga Parbat, the point at which Lake has to end his Himalayan arc. Moreover, as recently pointed out by Auden, our increasing knowledge of the structure of the Himalaya shows that not only are there a number of thrust planes of paramount importance within the Himalaya, but also that the angle of these thrusts is extremely variable and does not conform to the low angle required by Lake's hypothesis. As he




Trend Lines of the Mountain Ranges of the Himalaya and Tibet.
(Mainly after Burrard).

**Fig. 1.**

considered, the Himalaya are but a part of a much more extensive mountain system, which continues to the south-west through Baluchistan and Persia, and to the south-east through Burma. And since they have been formed on the site of a long geosyncline by the crushing of its deposits through the movement of Eurasia and Gondwanaland towards one another, the shape of the mountain system so produced must be determined partly by the original disposition of the geosyncline, and partly by the shape of the two impinging masses. Further, as says, it would appear impossible to regard any single dislocation or nappe as having borne the whole burden of the advance upon the foreland.[19]

On the other hand, Burrard, as a geographer, considers that there is no Himalayan arc at all; for in his opinion the Himalaya cannot be considered independently of the mountains further north, including the Kun Lun, the Tien Shan, the Karakoram and the Hindu Kush, ranges

[19] *Rec. Geol. Surv. Ind.*, 1934, **67**, 448.

which either show no curvature at all, or curve northwards.[20] But this view ignores the important geological fact that while the Himalaya and its immediately associated mountain ranges are, at any rate mainly, of Kainozoic age, the Kun Lun, the Tien Shan, and possibly the others also, are much older having been formed most probably at the end of the Palæozoic (Hercynian). It does, however, contain a germ of truth. It is a well-established principle that older structures frequently play an important part in influencing the formation of later structures. And although the great Himalayan arc is no doubt to be regarded as essentially Kainozoic in origin, it is yet a moot point as to the extent to which an older 'grain' may still be preserved within the main Kainozoic superstructure. The point is referred to again below.

To make clear the foregoing remarks, the main trend lines are shown in Fig. 1, which is mainly copied from the frontispiece of Burrard and Heron's *A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*, with certain additions and simplification.

*(To be continued.)*

[20] Reference 18, p. 75.

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# Progress of Algological Studies in India.

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THE study of Botany dates as far back as somewhere 2,500 years ago. But apart from its mainly applied side not much attempt was made to investigate the Indian plants from purely scientific aspect. The first impetus to the systematic study of Indian Botany was given by the Governor of Malabar by the publication of the memorable volume entitled *Hortus Malabaricus* during the last decade of the 17th century. But the critical study of Indian plants along the modern lines was systematically taken up by Dr. William Roxburgh, 'the father of Indian Botany', since his appointment as the first Superintendent of the Royal Botanic Garden, Calcutta, the then East India Company's garden, in 1793, although Dr. Roxburgh for many years prior to his transfer to the Royal Botanic Garden had been engaged in studying the then little known flora of the Northern Circars in the Madras Presidency.

Very little attempt was, however, made to investigate the lower plants of this vast country. Bryophyta and algæ were left untouched till very late years, although study of these branches of Botany was started in Europe earlier than 1753—from the time of Linnaeus onwards.

Dr. Alexander Braun and Dr. W. H. Hervey mentioned about Belanger's and Wight's collection of Chara and seaweeds as early as 1826-28. Collection and study of algæ can thus be traced from the period of 1798 onward, when var. *Ceylonica* of *Chara polyphylla* A. Braun, was first detected in Ceylon by Lebeck in 1798 (according to Klein in *Herb. Willd*), and afterwards collected near Tranqueber. Robert Wight, M.D., F.R.S., the distinguished Indian Botanist, and a member of the Honorable Company's Madras establishment, published the Icones Plantarum Indiæ Orientalis. He issued, in collaboration with Dr. Walker Arnott, the first volume of Prodromus Floræ Orientalis, an admirable work which unfortunately was never completed. Iyengar's* reference to Wight's algal work in this volume cannot be traced. As far as could be found from the literature available at my disposal Belanger was the first to admire the treasures of the Indian Sea. In 1836, as Director of the Botanic Gardens in Pondicherry, he collected seaweeds along the coasts of Cape Comorin and its neighbourhood in South India. Jaimes Forbes Royle, Late of the medical staff of the Bengal Army, added a short note on Algæ in his monumental work on the "Illustrations of the Botany and other branches of the Natural History of the Himalayan Mountains and of the Flora of Cashmere," 1839, Vol. I, pp. 441-442. In this note Royle suggests that "the Dictyoteæ

* Iyengar, M. O. P., Presidential Address (Section of Botany), Fifteenth Indian Science Congress, 1929.

increase in numbers as we approach the equator; and *Hypnea*, *Cystoseria*, *Sargassum*, *Zonaria*, *Spharococcus*, *Thamneria*, *Acanthophora*, *Tamnophora*, *Amansia*, *Caulerpa*, and *Gelidium*, of which swallows build the so much prized 'edible bird's nests' abound in tropical seas. Few have been described from the Indian Ocean, but several are contained in Dr. Rottler's Herbarium." He also mentioned that "A few species of Confervas" are found in Dr. Rottler's Herbarium from the neighbourhood of Tranqueber. I do not find mention of "snow algæ in the Himalayas and some Lemaneaceæ in the cold mountain torrents" as stated by Prof. M. O. P. Iyengar. Royle simply makes a general remark about "Red snow which may be found in the Himalayas together with some freshwater Confervæ", while of the true Fuci, the Lemanias are only found in the freshwater of mountain torrents. Royle's note on the economic uses of the algæ is also very suggestive.

William Griffith, a Surgeon in the Honourable Company's Madras establishment, was one of the most brilliant of the Indian Botanists, who had had a varied interest and extensive knowledge in different branches of Botany. Huge accumulations of his gatherings from different parts of the Indian Empire and Malay Peninsula and his vast accumulations of notes and manuscripts were posthumously published in nine volumes under the editorship of Dr. McClelland at the expense of the Honourable Company during the middle of the 19th century. Among his papers of 1849, on Cryptogams are published with illustrations seven members of the family of Characeæ, a highly specialised group of algæ. Of these *Chara involucrata*, *C. erythrogyna*, *Chara* sp. and *C. furcata* were collected from Serampore, Bengal; *C. soluta* from Hardwar, U.P., and *C. spagnoides* from "cabul". His new species named after Voigt—*Lysimoscepas voigtii*, as Griffith's figures show is a *Chara* sp. Prof. Iyengar's remark that "Griffith has described and has figured six Characeæ from upper India and Kabul", mentioned in his presidential address, is thus modified more accurately here. There is hardly any mention of algæ in Griffith's work "on Cryptogamic plants of Dr. Roxburgh in Flora Indica of Roxburgh" as referred to by Iyengar, in Vol. IV, *Cal. Jour. Nat. Hist.*, 1844, noted in the list of literature appended to Iyengar's presidential address. In 1819 Dr. Alexander Braun made a contribution entitled "Characeæ Indiæ Orientalis et insularum maris pocifici"—published in Hooker's *Journal of Botany*, Vol. I, pp. 292-301. In this paper Braun has described four species of *Nitella* and eight species of *Chara*, most of which were collected by Belanger during 1826-28 on the coast of Coromandel and by Dr. Wight. The collections were preserved in Hooker's Herbarium. Dr. W. H. Hervey described in 1854 three charming sea-plants from the south coast of Ceylon under three genera, of which the genus *Vanvoorstia* named after the reputed naturalist John Van Voorst, author of the *Natural History of Great Britain*, was established for the first time by him. The three species mentioned are *Vanvoorstia spectabilis*, *Claudea multifida* and *Martensia spectabilis*. In 1858 H. J. Carter paid attention, for the first time, to the fertilisation of *Eudorina elegans* collected from some puddles in Bombay, and also reported occurrence of a few other members of Volvocaceæ and Flagelatta from the same locality including a new species of *Ceratium* from Lake Nynee (Nainital), Kumaon. This was published in the *Ann. and Mag. of Nat. Hist.*, 1871, whereas his former paper on "Ficundation in *Eudorina elegans* and *Cryptoglena*" and "on the Ficundation of two volvoces and their specific differences" were published in the *Ann. and Mag. of Nat. Hist.*, 1858 and 1859. Dr. G. C. Wallich in the *Ann. and Mag. of Nat. Hist.*, 1860, **5**, 3rd Series, No. 27, pp. 184-197, wrote on the "Descriptions of Desmidiaceæ from Lower Bengal". He mentions seven genera and eight species of filamentous Desmidiaceæ, namely, *Hyalotheca*, *Desmidium*, *Ap'ogonium*, *Sphærozosma*, *Leusonema*, *Onychonema* and *Streptonema*, together with his observations on the periodicity of these algæ which were obtained from the neighbourhood of Raneegunge during the latter months of 1855. The same author, Surgeon Wallich of the Indian Army, read an interesting paper on the "Siliceous organisms found in the digestive cavities of the Salpæ and their relation to the Flint nodules of the Chalk formation," before the Transactions of the Microscopical Society, London, on December 14th, 1859. This noteworthy publication "intended to embrace under this head the whole of the molluscoid tribes that frequent the open sea in shoals and live upon the microscopic organisms it contains," is published in the *Trans. of the Micro. Soc. Lond.*, New Series, 1860, **8**,

36-55. A. Grunow wrote an account on the Freshwater Diatoms and Desmids of the Banka Island near Singapore in his paper entitled "Süsswasser—Diatomaceen und Dismidiaceen von der Insel Banka" in *Rab. Beitr. Zur. Ken. U. Verb. Algen, Leipzig*, 1865. Hobson in the *Quarterly Journal of the Micro. Science*, wrote: "Notes on Indian Desmidiaceæ" in 1863, and described two new species *Docidium Pistidæ* Hobs., *Micrasterias Mahabuleshwarensis* Hobs., collected from Mahabuleshwar, Bombay Presidency. Dr. G. V. Martens, High Councillor of Finance in Stuttgard, during 1871-73 published in the *Proc. of the Asiatic Society of Bengal* the result of his work on "Some Bengal and Burmese algæ collected by S. Kurz". In the *Journal of the Asiatic Society of Bengal*, 1873, **42**, G. Zellar recorded 155 species of algæ collected by S. Kurz from Arracan and British Burma. In 1879 Leuduger-Fortmorel drew up a "Catalogue des Diatomees de L'ile de Ceylon". A few interesting algæ collected from the Himalayas were examined by Dr. G. Dickie, F.R.S., and his "Notes on algæ from the Himalayas" was published in the *Journal of Linn. Soc. Bot.*, 1882, **19**. His note is supplemented by Grunow's report. W. Theobald added "A List of Burmese Desmids" in *Burma: Its People and Productions*, **2**, 16-30, 1883. W. Joshua recorded "Two Desmids from Rangoon" in *Jour. of Botany*, 1885. Next year the same author added a valuable contribution on "Burmese Desmidiaceæ" together with coloured illustrations in the *Jour. of the Linn. Soc. Bot.*, 1886, **21**, enumerating 186 species and varieties. J. Schaarschmidt in his "Notes on Afghanistan Algæ," published in the *Jour. of the Linn. Soc. Bot.*, 1886, **21**, described 60 species of algæ which were all carefully separated and examined from dried materials adhering to phanerogamic specimens chiefly to *Ammania pentandra*. These phanerogams were collected by Dr. J. E. C. Aitchinson, Surgeon-Major to H. M. Bengal Army in the Afghanistan expedition of 1880. G. Murray is the author of "Catalogue of Ceylon algæ in the Herbarium of British Museum", which was published in the *Ann. and Mag. of Nat. Hist. Lond.*, 1887. G. Lagerheim contributed towards our knowledge of Bengal Desmids in his paper entitled "Über Desmidiaceen Aus Bengalen" in *Akad. Handl.*, 1888, **13**, Afd. iii, No. 9, where he refers to 52 species and varieties. Then follows the valuable memoir of Prof. W. B. Turner under the title of "Algæ aqua dulcis Indiæ orientalis," "Freshwater algæ of East India" in *Kong. Sv. Vet. Ak. Handl.* (1892), 1893, **25**, Part I, pp. 1-186, accompanied by 23 plates. The manuscript of this paper was compiled in 1885-86 but was published in 1892. The materials of this valuable contribution to Indian Algæ consist of residue of Dr. Wallich's collection of 1855 which was subsequently supplemented by that of Dr. G. Von Lagerheim, who sent to Prof. Turner some specimens of Indian Utricularias—from the Riks Museum in 1889. Turner in his work mentions 22 species of Myxophyceæ, 542 species of Desmids and 60 species of Chlorophyceæ exclusive of Desmids. It appears that some of the species demand reduction in their specific rank and alteration in their specific names in the light of the modern rules of nomenclature. But this point in no way lessens the great importance of the paper. His remarks on the periodicity of the algæ in relation to their habitat is worth consulting. W. West and G. S. West described in their paper on "Desmids from Singapore", 45 species from Singapore, Burma, which were collected by then by Mr. H. N. Ridley, and published in the *Jour. of the Linn. Soc.*, 1897, **33**. O. Borge's paper on "Über tropische und subtropische süsswasser—Chlorophyceen" in *Bih. Till. K. Sv. Vet. Akad. Handl.*, 1899, **24**, Afd. IV, No. 12, marks the closing of the study of Indian Algæ up to the year 1900. During the first decade of the 20th century literature on Indian Algæ was considerably enriched by the noteworthy publications of the well-known algologists—Profs. W. West and G. S West, Dr. Nils Svedelius and Prof. F. E. Fritsch. In the *Transactions of the Linn. Soc. Bot.*, Series 2, 1902, **6**, we find W. West's and G. S. West's article on "Freshwater Algæ from Ceylon". This valuable contribution on Freeman's collection of 7 species of Rhodophyceæ, 49 species of Diatoms, 33 species of Myxophyceæ, 246 species of Desmids and 84 species of other Chlorophyceæ appreciably advanced the progress of algological researches in India. Next year appeared the two important papers by Mrs. A. Gepp (Barton, E. S.). One of these is "List of Marine Algæ collected at the Maldive and Laccadive Islands by J. S. Gardiner" published in the *Jour. of Linn. Soc. Bot., London*, 1903, **35**, No. 247; and the other is "List of Marine Algæ with a note on the fructification of Halimeda" published in the

Report on the Pearl Oyster Fisheries of the Gulf of Mannar by W. A. Hardman in the *Jour. of the Royal Soc., London*, Pt. I, 1903. The valuable monograph on the "Report of the Marine Algæ of Ceylon, No. 1, Ecological and Systematic Studies of Ceylon species of Caulerpa," by N. Sreedelius was published in the "Biological Results of the Ceylon Pearl Fishery," No. 1, Art. 4, 1904. Sir David Prain in "The Vegetation of the Districts of Hughli, Howrah and 24 Pergunnahs" published in the *Rec. Bot. Surv. of India*, 1905, **3**, No. 2, reports 84 species of algæ from the three important districts of Bengal. W. West and G. S. West record 58 species of Diatoms, 148 species of Desmids and 53 species of other green algæ which were collected by Mr. I. H. Burkill chiefly from Burma. The result of their study is embodied in the *Annals of the Royal Botanic Garden*, Calcutta, 1907, **6**, Pt. 2, under the heading "Freshwater Algæ from Burma including a few from Bengal and Madras". F. E. Fritsch in his account on "A general consideration of the Sub-aerial and Freshwater Algal Flora of Ceylon", a contribution to the study of Tropical Algal Ecology, Pt. I, Subaerial Algæ and Algæ of the inland Freshwater published in the *Proceedings of the Royal Soc. of Lond.*, Series B, 1907, **79**, suggested extensive scope of studies on the ecology of algæ in India. The year 1911 concludes with W. West's short paper on "Descriptions of the new species of algæ associated with freshwater Polyzoa, with notes by Dr. N. Annandale" published in the *Jour. and Proc. of the Asiatic Soc. of Bengal* (New Series) **7**, No. 3. This marks the cessation of activities of the continental algologists working on Indian materials up to the year 1926 when Nellie Carter's "Freshwater Algæ from India" made further addition to the progress of Algological studies in India.

The period between 1911 and 1919 indicates a dormant stage in the history of Algological researches in India. In 1914 at the inaugural meeting of the Indian Science Congress at Nagpur, Dr. Paul Brühl while discussing the various avenues of researches on Indian Botany laid particular stress on the study of Algæ in India in consideration of the vast mines of Algal wealth of this country. He went even so far as to suggest the formation of an Algological Society in India which to the great enthusiasm and interest of Indian Botanists developed into the present Indian Botanical Society.

Then came the period of renaissance in the history of Algological researches in India. It is indeed a matter of glory and satisfaction that from 1920 up to the present, the contributors are nearly all Indians. The names of Dr. S. L. Ghose (Punjab), Prof. M. O. P. Iyengar (Madras), Dr. P. Brühl and K. Biswas (Bengal) may be mentioned as the pioneer workers in the study of Indian Algæ. Very lately Dr. Y. Bharadwaja is attempting to solve the mystery of the life history of several genera of blue-green algæ of the United Provinces. Prof. Dixit of Bombay Presidency has also, by his notes on algæ, evinced his interest in the study of this branch of Botany. Messrs. Handa and Paul have also by their publications advanced the progress of our knowledge of Burmese blue-green and green algæ and members of Characeæ. Our knowledge of Characeæ has considerably been advanced by the studies of J. Groves in his papers on "Charophyta from Ceylon" published in *Jour. Linn. Soc. Bot.*, 1922; and "Notes on Indian Charophyta," *Ibid.*, 1924, **46**. Paul's recent work on Characeæ was preceded by G. O. Allen's paper on "Notes on Charophyta from Gonda, U. P." published in *Jour. Bomb. Nat. Hist. Soc.*, 1925, and a few others. The papers of these Indian workers Ghose, Iyengar, Bharadwaj and the author of this article are too many to mention here. Ghose is chiefly interested in the blue-green algæ of the Punjab and about half a dozen of his important papers have already been absorbed in the literature on Indian Algæ. He is at present, in collaboration with his students, actively engaged in the study of algæ of the Punjab. Iyengar has mainly devoted his attention to the study of green algæ and out of his about a dozen important contributions to our knowledge of the Indian green algæ, his investigation on Echballocysts and Madras Volvocaceæ throws much light on many a doubtful problem in the life history of these algæ. The writer himself and in collaboration with Brühl added to the literature on Indian Algæ more than twenty papers including some of the memoirs containing descriptions of many new species and observations on the nature of the growth and distribution of the algæ recorded. Systematic morphology and ecology of blue-green and green algæ and also of Diatoms have at present been the favourite subjects for the study of the writer. Those who desire to have further information of the papers of the algologists mentioned above may correspond direct with them. Prof.

Borgesen who paid visits to the Bombay sea coasts is at present engaged in the study of the marine species, and his recent publications are substantial additions to our knowledge of marine algæ of the Malabar coasts.

The progress of the study of Indian Algæ thus may be divided in three well marked periods: first the early period: 1798-1860; secondly, the middle period: 1861-1900; thirdly, the recent period: 1901-1934. Regionally Bengal, Southern India and Burma including the Malaya Peninsula were the centre of activities from the early period up to the present time. Ghose and Bharadwaj are attempting to establish centre of algological studies in their own province too. It is hoped that in the near future batches of algologists in each of the provinces will be forthcoming to increase and further our knowledge of Indian Algæ.

The scope of Algological studies in India have already been discussed in the presidential addresses of Prof. M. O. P. Iyengar and Dr. S. L. Ghose as presidents of the Botany Section of the Indian Science Congress in 1929 and 1933, the author of this note in his contribution entitled "Census of the Indian Algæ: Scope of Algological Studies in India", Part I, published in *Revue Algologique*, 1932 Tom. **6**, Fasc. 2, and "Role of Aquatic Vegetation in the Biology of Indian Waters", published in Sir P. C. Ray's Memorial Volume, 1933, dealt upon the same subject. In consideration of the vast materials of Indian Algæ a school of Indian Algologists is necessary to work out materials of the unexplored area. We have not yet been able to make a systematic survey and are still in the dark as to the number of species occurring in a locality and their distribution in different parts of the country. Very small percentage of the Indian species of Myxophyceæ, Chlorophyceæ and Diatoms are known to the world. The necessity of the investigation was also felt by the Government of India, as the following report of the thirty sixth meeting of the Board of Scientific Advice to consider the proposal for reorganisation of the Botanical Survey of India indicates: "The appointment of a cryptogamic botanist to the Botanical Survey was urged by Sir D. Prain when Director of the Survey about 1900. It was strongly supported at home by Sir George King, the previous Director and by Thiselton Dyer, the head of Kew. The post was created in 1901, but was transferred to the Agricultural Department a year later and the incumbent instructed to specialise in the diseases of plants. Cryptogamic botany has not since formed any part of the activities of the Survey and the position still is that save as regards ferns no special attempt has ever been made by the Botanical Survey to prosecute the systematic study of the cryptogamic vegetation of the country, if we omit a few collections made during the last century." Sir David in a recent letter to the writer has again, even after so many years, emphasised the urgent need of algological investigation.

I can therefore safely assure a bright future for the enthusiasts in the study of Algology in India not only for the sake of study of this fascinating subject from the standpoint of pure scientific investigation, but also for the considerable importance of the practical utility of Algæ as food in pisciculture, antimalariological operation, filter works, soil fertility and so on. Younger generation taking interest in this line can profitably undertake the study of Indian Algæ under the authorities and very well devote their life in advancing our knowledge of the vast unknown field of Algological investigation in India. Ghose and Iyengar, to my information, have already sufficient accumulated materials awaiting investigation of several workers. The writer also has in his possession precious collections of large amount of materials from the Late Dr. Dudgeon of Allahabad, the Late Rev. Dr. E. Blatter of Bombay and the Late Dr. S. K. Mukerjee of Lucknow the three brilliant Indian Botanists, whose irreparable loss we all mourn to-day. The writer humbly hopes to dedicate the results of his works on these collections to each of these botanists and thereby commemorate their great interest in the progress of algological studies of our country, for which they spared no pains to gain these valuable materials properly preserved which is by no means an easy task.

# On the Neural Gland, Nerve-Ganglion and Dorsal Tubercle of *Herdmania pallida* Lahille (the Typical Monascidian of the Indian Seas).

By S. M. DAS, D.SC.

*Department of Zoology, The University, Lucknow.*

THE monascidian *Herdmania pallida* Lahille[1] (*Rhabdocynthia pallida* Herdman) is dissected and studied as a type of the Tunicata in almost all the Universities of India, Burma and Ceylon. But no published account of its anatomy exists. Teachers and students usually seek help from accounts of *Ascidia*[2] and *Ciona*, the European monascidians, which are totally inadequate for a study of the Indian form *Herdmania*. The author has completely worked out the Anatomy, Histology, Bionomics and Distribution of this animal, a monograph on which will soon appear for use in the Indian Zoological Laboratories.

During the investigation a number of new and unexpected features have been found, but, in this article, the author confines himself to the structure, relationship and homology of the neural gland, nerve-ganglion and dorsal tubercle of *Herdmania pallida*. It may be mentioned here that, though a study of these three organs forms a very important part of the dissection of the ascidian in the graduate and post-graduate courses in Zoology, in India, their morphology has been wrongly interpreted for a decade or more since the substitution of ascidians from Tuticorin and Ennur for those formerly obtained from Naples and Plymouth.

The neural gland, nerve-ganglion and dorsal tubercle are all situated in the intersiphonal region of the animal, the former two lying imbedded in the mantle and the last projecting into the branchial cavity, in the prebranchial zone (Fig. 1). In the European forms *Ascidia* and *Ciona* the nerve-ganglion is situated dorsally to the neural gland (Fig. 2), but in *Herdmania* the nerve-ganglion always lies ventrally to the neural gland (Fig. 1). This change in position is attended with an alteration not only in the general lay-out of the three organs but also in their size, form and structure.

The *neural gland*, lying just above the nerve-ganglion, is a light brown oval structure about 4 mms. long, 2 mms. wide and 1 mm. thick. The gland consists of a large number of branching tubules given out towards its periphery from a few central tubes which open into a long non-ciliated canal running along the whole length of the gland (Figs. 3 and 4). At its anterior end this canal leads into a duct that passes downwards, between the nerves given out from the ganglion, and opens into the antero-dorsal region of the branchial cavity by a wide

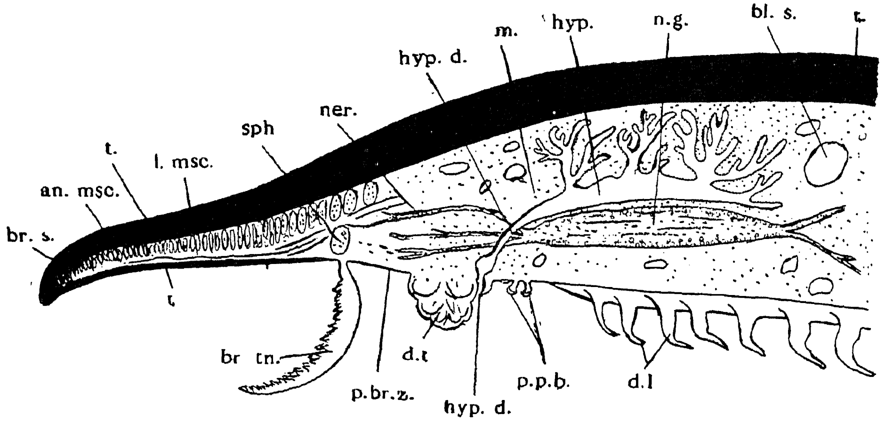


**Fig. 1.**

Longitudinal section of the neural gland, nerve-ganglion and dorsal tubercle of *Herdmania pallida*.

*br. tn.*—branchial tentacles; *d.l.*—dorsal lamina; *d.t.*—dorsal tubercle; *hyp.*—neural gland; *hyp.d.*—neural duct; *n.g.*—nerve-ganglion; *p.p.b.*—peri-pharyngeal bands.

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[1] *C.R. Assoc., Franc. Sess.* 16, 1888, **2**, 677.

[2] *L.M.B.C. Memoirs, Ascidia*, 1899.

ciliated funnel-shaped opening at the middle of the basal part of the dorsal tubercle. This wide funnel is absent in *Ascidia*. The lumen of the gland as well as its ducts are lined with a single layer of small non-ciliated rounded cells containing large nuclei. The rest of the gland consists of a large number of small dark granulated cells with large nuclei, some scattered blood-corpuscles and some blood-sinuses traversing the substance of the gland (Figs. 1, 3 and 4). A large number of cells filled with dark granules are discharged into the lumen of the gland, from where they pass out, through the main duct, into the branchial cavity. The dark granules are excretory products absorbed by the cells. The ciliated cells, lining the funnel-shaped opening, are of the same kind as those covering the dorsal tubercle, the cilia being about double the length of the cells themselves.

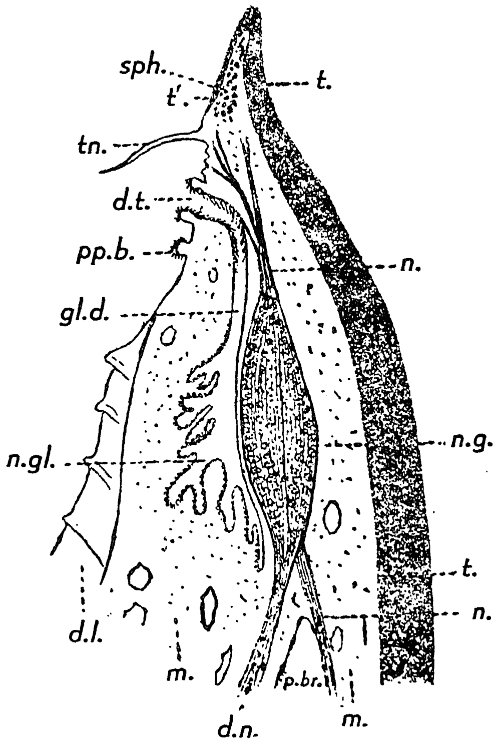


**Fig. 2.**

Longitudinal section of the nerve-ganglion, neural gland and dorsal tubercle of *Ascidia* (from Parker and Haswell).

*n.g.*—nerve-ganglion; *n.gl.*—neural gland; *d.t.*—dorsal tubercle.

The *nerve-ganglion* forms an elongated, solid pinkish mass—about 4 mms. long and 1 mm. thick—lying ventrally to the neural gland. It gives off three nerves anteriorly (*i.e.*, towards the branchial siphon) and two posteriorly (*i.e.*, towards the atrial siphon) (Fig. 1). Of the three anterior nerves two are stouter than the third, and these, soon after their origin from the ganglion, diverge and run, one on each side of the posterior margin of the branchial siphon, along the base of the circle of tentacles. They thus approach each other on the ventral side of the branchial siphon and end in fibres that branch but do not anastamose. All along their length they send branches into the tentacles and to the muscles and inner epithelium of the siphons. The third nerve, which is finer than the other two, arises in between them and runs towards the branchial aperture, obliquely across the wall of the siphon, sending nerve-fibres to the muscles and the epithelium of the siphon. The two nerves arising from the posterior end of the ganglion diverge and encircle the base of the atrial siphon, sending branches to the muscles and the epithelium of the atrial siphon. The ganglion consists of an outer covering of very large cells with large nuclei and a main central zone of a loose fibrous matrix in which a large number of bi-polar and multi-polar nerve cells are imbedded. The large cells of the outermost layer—" the ganglion cells "—are oblong in outline and contain thickly granulated cytoplasm in which is imbedded a large nucleus. The central zone consists of a mass of inter-lacing nerve fibres in which a large number of nerve cells with two or more dendrites are scattered.

The *dorsal tubercle* is situated below the nerve-ganglion, in the pre-pharyngeal zone, near the junction of the peri-pharyngeal bands with the dorsal lamina. It consists of a broad base and two conical projections, each of which is formed of a spirally coiled lobe that tapers towards the summit of the tubercle (Fig. 1). In *Ascidia* and *Ciona* the tubercle is a simple horse-shoe-shaped structure, without the conical lobes, and is much smaller in size than in *Herdmania*. The basal part consists of a hemispherical concave lobe over which lies a convex dome-shaped lobe. In between the two spiral coils lie gaps or open channels which form a continuous open channel from the base of the tubercle to the tip of each cone (Fig. 3). The two channels of the two sides meet

under the dome-shaped hemispherical basal lobe, and form the concave base, in the centre of which the ciliated funnel opens. The general surface of the organ, except the bottom of the most proximal groove, is covered by a single layer of tall cylindrical columnar epithelial cells copiously provided with very long cilia. The rest of the tubercle consists of loose connective tissue containing a large number of extensive blood-sinuses, connective tissue cells scattered throughout and a number of nerve-fibres that supply the covering epithelium of the organ.

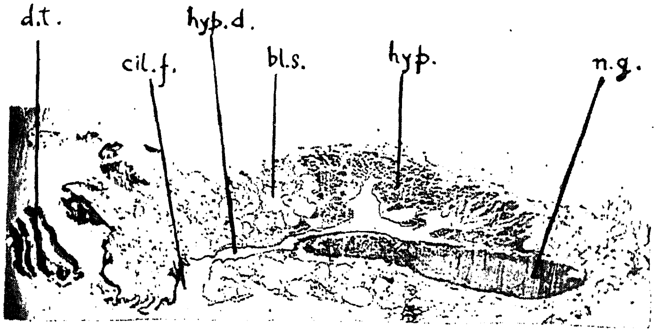


**Fig. 3.**

Photo-micrograph of a longitudinal section through the neural gland, nerve-ganglion and dorsal tubercle of *Herdmania pallida*.

*bl.s.*—blood-sinus; *cil f.*—ciliated funnel.

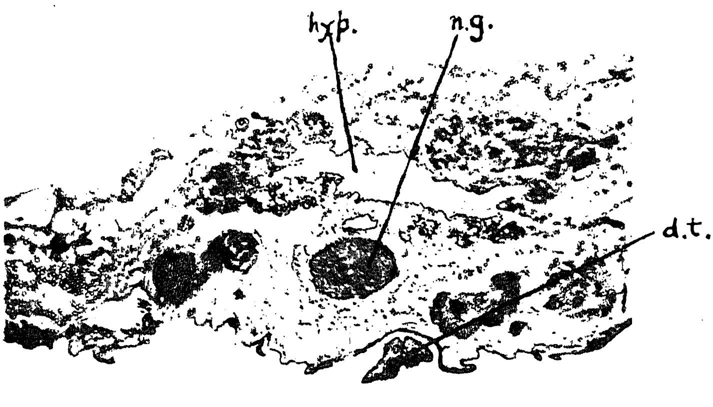


**Fig. 4.**

Transverse section through the neural gland, nerve-ganglion and dorsal tubercle of *Herdmania pallida* (Photo-micrograph).

The homology and function of the neural gland and the dorsal tubercle have been subjects of much dispute. Early investigators described the dorsal tubercle and the ciliated funnel as an olfactory organ. Julin considered it merely as the opening of the neural gland. But the rich innervation of this organ, as Metcalf[3] and Hunter showed, points to a sensory function. The actual sensory function subserved may be gustatory or olfactory, or, as the author thinks, both—since both functions could be efficiently performed by a pre-pharyngeal sense-organ like the dorsal tubercle. Metcalf demonstrated that the opening of the neural gland into the pharynx is a modified neuro-pore and favoured the view put forward by Julin that the neural gland is the morphological equivalent of the hypophysis cerebri of vertebrates. Julin also suggested that the gland subserves an excretory function. Lacaze-Duthiers[4] tried to establish the theory that the neural gland secretes mucus which is poured into the pre-pharyngeal zone of the gut and serves the purpose of

[3] *J.R.M.S.*, 1901.

[4] *Mem. Acad. Sci. Inst. France*, T. **45**, 1.

entangling microscopic food particles brought in with the water current. But this theory can in no way be correlated with the facts: (1) that the main work of food collection is done not in the pre-pharyngeal zone but in the pharynx itself, (2) that the endostyle is the main mucus secreting organ and supplies the peri-pharyngeal zone with the necessary mucus, and (3) that cells containing dark granules are secreted into the cavity of the neural gland and are discharged therefrom into the branchial cavity. The structure of the neural gland in *Herdmania*, the fact that the secretion of the gland originates by the disintegration of cells proliferated from the endothelium of its walls and the presence of dark granules in the excreted cells, strongly indicate that the gland subserves an excretory function. The opening of this gland at the base of the sensory dorsal tubercle is, however, a problematical association. But, as Herdman[5] pointed out, this connection between the duct of a gland and a pre-pharyngeal sense organ may be a secondary and purely accidental relationship.

The relative position of the neural gland, nerve-ganglion and dorsal tubercle is also of phylogenetic importance. The dorsally situated neural gland of *Herdmania*, which belongs to the Cynthiidæ, has thus far been found in only one other family of ascidians —the Botryllidæ. But Botryllidæ are compound ascidians and as such can have no direct relation with the Cynthiidæ, which are simple ascidians, according to Herdman's system of Tunicate classification[6] followed in most text-books of Zoology. On the other hand, the similarity in the dorsally situated neural gland points to a common origin of the Cynthiidæ and the Botryllidæ. A number of other examples from Herdman's system of classification show an unnatural separation of forms admittedly allied. *Clavellina* and *Diazona* are more similar in structure to *Ciona* than to *Coelocormus* or *Perophora*.[7] These affinities can be proved embryologically also. It is certain, therefore, that the compound ascidians are not a closely knit group of ascidians obtained from one common stock, but that they have evolved separately from different simple ascidian stocks to which they are more closely related than to other compound ascidians.

The author wishes to express his thanks to Dr. Sundara Raj of the Madras Fisheries Department for placing the resources of the Tuticorin Fisheries Station at his disposal for the collection of material. To Professor K. N. Bahl he is very much indebted for taking keen interest in the progress of the work and for valuable criticism.

[5] *Proc. Roy. Soc. Edin.*, 1883, **12.**

[6] *Journ. Linn. Soc. Zool.*, 1891, **23.**

[7] Garstang, *Rep. Brit. Assoc.*, 1895, 718-19.

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# Obituary.

## Shiv Ram Kashyap (1882-1934).

RAI BAHADUR DR. S. R. KASHYAP, B.A. (Cantab.), D.Sc. (*Honoris Causa*, Panjab), I.E.S., F.A.S.B., Professor of Botany, Government College, Lahore, and of the Panjab University and Honorary Professor of Botany, Hindu University, Benares, died suddenly at Lahore, on the 26th November, 1934, of heart-failure. Even half an hour before his death, he was attending to his work with his characteristic thoroughness.

To-day his country is the poorer by the loss of one of its best-known and best-beloved intellectuals. As a scientist, he was respected all the world over and as a teacher he will be mourned by a host of admiring students all over the country, many of whom are holding University Chairs in Botany and other important appointments. For ever, he will be looked upon as one of the chief makers of modern Indian Botany. His pioneer researches on Himalayan Liverworts will go down to posterity as a great scientific achievement which will keep alive his memory for ever.

In his early life, Kashyap had a brilliant and remarkable academic career which can seldom be rivalled. Born on 6th November 1882 at Jhelum of a family with a long record of meritorious military services, he matriculated from the Panjab University in 1899. In 1900, he joined the Medical School at Agra and received his Medical Diploma in 1904, topping the list of successful candidates and winning the First Medal. He then served for two years in the Medical Service of the United Provinces.

While still a student of the Medical School he appeared as a private candidate for the Intermediate science examination

of the Panjab University and not only succeeded in passing the examination in the first division but stood at the top of the list in the University. He was offered a university scholarship but this he declined to accept and went on with his studies at the Medical School. In 1906, while serving in the Medical Department of the United Provinces, he again appeared as a private candidate for the B.Sc. examination of the Panjab University and again topped the list of successful candidates. In the same year he resigned his post in the Medical Service and was appointed Assistant Professor of Biology at Government College, Lahore. In 1909, he passed the M.Sc. examination in Botany, again getting a very high first class and standing first among the M.A. and M.Sc. candidates in the University. As a result he was awarded the much-prized Arnold and Maclagan Gold Medals of the University.

In 1910, he went to Europe and joined the Cambridge University from where, in 1912 he took his Honours Degree in the Natural Science Tripos.

On his return home, Professor Kashyap was appointed Professor of Botany at the Government College, Lahore, in the senior grade of the Provincial Educational Service and was promoted to the Indian Educational Service in 1920. In 1919, when the Honours School in Botany was organised by the Panjab University, he was appointed University Professor of Botany, in which capacity he continued to serve the cause of education until his death.

Dr. Shiv Ram Kashyap

He had been an elected Fellow of the University for many years and the Dean of the Science Faculty for a long time. He was also a member of the Syndicate and in 1931 officiated as Dean of University Instruction for some months. He had been for several years a member of the Science Faculty and of the Boards of Studies of several other Universities also, such as Agra, Lucknow and Benares. Professor Kashyap was the first systematic botanist to preside over the annual deliberations of the Indian Science Congress in 1932, ever since it was founded in the year 1914. It was the highest honour that the Indian scientists could confer on him. In recognition of his valuable contributions, the Panjab University, in 1933, conferred on him, *Honoris Causa*, the Degree of Doctor of Science.

He was the first secretary of the Indian Botanical Society, which was founded in 1920, and did all the spade work in its organisation. He was its President in 1925 and was the Editor-in-Chief of its organ, the *Journal of the Indian Botanical Society*. He was also an Advisory Editor of *Chronica Botanica*, published from Holland. He was elected President of the Botany Section of the Indian Science Congress in 1919 when the Congress met at Bombay.

He contributed numerous papers on various groups of the Vegetable Kingdom. His contributions to three subjects—the sexual generation of Equisetum, the Liverworts of the Western Himalayas and the flora of Tibet—however, stand out above all others. One of his very first papers appeared in 1919, in which he described the structure and development of the sexual generation of *Equisetum debile*, one of the Indian members of the family of horsetails, growing at Lahore, which was quite different from what was known up to that time in many species worked out by European and American investigators. The account was so different that some people even made adverse remarks in the beginning but later they all agreed when they saw the specimens. In 1917, Prof. Kashyap suggested that the sexual generation of other species would also show a similar structure as seen in the Indian species if certain conditions with regard to space and nourishment were fulfilled. Later work has shown how prophetic his prediction was.

The second subject of Prof. Kashyap's investigations has been the little group of

Liverworts or *Hepaticæ*. His contribution to the knowledge of the West-Himalayan Liverworts has been very great and this may be regarded as his chief subject. He described 4 new genera and over 30 new species of Liverworts. When his first paper on them was published Professor Goebel, of Munich University, one of the leading botanists of the World, wrote to him : "You have struck a gold vein in the Western Himalayas and made a most valuable addition to our knowledge of Liverworts." Professor (now Sir John) Farmer wrote, "I cannot refrain from congratulating you on the advance towards our knowledge of these interesting plants which you have been able to make."

His contribution to the Theory of Evolution by Reduction, in this group is very important and has been highly appreciated in Europe and America. He not only greatly expanded this theory and placed it on a strong basis but actually followed out the various lines of evolution. Dr. Cavers wrote to him, "I shall have to re-write the portion of 'Inter-relationships' dealing with the Marchantiales." Recently he published a monograph on the Liverworts of the Western Himalayas and the Panjab Plain. This is a very valuable piece of work and fills a great gap in the botanical literature of India.

The third subject to which Prof. Kashyap very largely contributed is the Flora of the Western Himalayas and Western and Central Tibet. He was a great traveller and probably knew more than anybody else about this interesting country. He crossed the Himalayas into Tibet at nine different places throughout its length and several times at some places. Among the regions visited by him are Ladak, the sources of practically all the rivers of the Panjab, the world-famous sacred country of Mountain Kailas and Lake Manasarovar, the sources of the Ganges and the Jumna, the country in the neighbourhood of Kanchenjunga, Gyantse, etc., etc. It may be said of him that he knew the Himalayas as one knows his own home. He brought back a very large collection of plants from these places, many of which have not been recorded from that country so far. Besides adding to the botany of these regions, he even extended their geographical knowledge. The exploration of the Himalayas and the study of its vegetation were his life's passion. It may not be known to all that years back when far out on the other side of the Himalayas, he fell ill and had to be brought down almost in an unconscious state. But that could not keep him back from further explorations in the following years. Last year, when up on the Himalayas, he again became seriously ill and had a bad attack of heart trouble. This year, he slightly recovered from its effects and was planning yet another trip to the Himalayas. With him, his work came first and if any one remonstrated with him for working so hard in his failing health, he would say "Why, my life is not more important than my work." Such was his love for his work. Those of us who had the rare good fortune of working with him as colleagues for a number of years look upon his death as a personal loss. A distinguished scientist, a pioneer botanist, a great teacher, and an indefatigable worker, an untiring Himalayan explorer, yes, he was all that but much more—he was, on top of everything else, a sincere friend and a generous helper to all his colleagues and pupils. Richly endowed with qualities of head, he achieved his tremendous popularity even more by his unique qualities of heart. He possessed in an extraordinary degree that sweet reasonableness which stamped him out at once as a gentleman and a man of true culture. All those who like me came in close personal contact with him, at once felt the subtle charm and magnetism and human warmth of his presence.

Such was the man who is deeply mourned to-day by a very wide circle of grief-stricken friends and admirers.

H. CHAUDHURI.

The following is a list of the publications of Professor Kashyap :—

(1) Notes on species of *Euglena* (*Records of the Indian Museum*, Calcutta, April 1908). (2) Structure and development of the Prothallus of *Equisetum debille* (*Annals of Botany*, London, January 1914). (3) Notes on New and Little-known West Himalayan Liverworts, No. 1 (*New Phytologist*, Cambridge, 1914). (4) Notes on New and Little-known West Himalayan Liverworts, No. 2 (*New Phytologist*, Cambridge, 1914). (5) Notes on New and Little-known West Himalayan Liverworts, No. 3 (*New Phytologist*, Cambridge, 1915). (6) The genus *Riccia* and the origin of the Pteridophytes (*Lahore Phil. Soc.*, June 1915) (*Proc.* for 1915-16). (7) Notes on *Targionia hypophylla*, (*New Phytologist*, Cambridge, 1917). (8) Notes on *Equisetum debille* (*Annals of Botany*, London, 1917). (9) Liverworts of the Western Himalayas and the Panjab Plain, No. 1 (*Jour. Bomb. Natur. Hist. Soc.*, 1916). (10) Liverworts of the Western Himalayas and the Panjab, No. 2 (*Jour. Bomb. Natur. Hist. Soc.*, 1917). (11) Notes on the inflorescence of *Zea Mays* (*Lahore Phil. Soc.*, June 1918) (*Proc.* for 1917-20). (12) Abnormal number

of needles in the shoots of *Pinus longifolia* (*Jour. Ind. Bot.*, 1919). (13) Presidential Address to the Botany Section of the Indian Science Congress at Bombay in Jan. 1919 (*Proc. As. Soc. Beng.*, New Series, Vol. 15, 1919, No. 4, The relationships of Liverworts, especially in the light of some recently discovered Himalayan Forms). (14) The Andrœcium of *Plagiochasma appendiculatum* L. and *P. articulatum* Kash. (*New Phytologist*, 1919). (15) Variability in some Himalayan Liverworts (*Lahore Phil. Soc.*, February 1917) (*Proc.* for 1917-20). (16) Distribution of Liverworts in the Western Himalayas (*Lahore Phil. Soc.*, November 1919) (*Proc.* for 1917-20). (17) Floating Islands of Riwalsar (*Jour. Ind. Bot.*, April 1920). (18) Notes on the distribution of Liverworts in the Western Himalayas, Ladak and Kashmir (*Jour. Ind. Bot.*, May 1921). (19) Some observations on *Cycas revoluta* and *C. circinalis* growing in Lahore (*Jour. Ind. Bot.*, June 1921). (20) Notes on some Foreign Plants which have recently established themselves about Lahore (*Jour. Ind. Bot.*, December 1932). (21) A contribution to the Life-history of *Aneura indica* St. (*Jour. Ind. Bot.*, December 1922, jointly with S. K. Pande). (22) A long-lost Liverwort (*Monoselenium tenerum*), (*Jour. Ind. Bot. Soc.*, 1923). (23) Two Indian species of the genus *Notothylas* (*Lahore Phil. Soc.*, November 1923, Vol. 4). (24) Some abnormalities in the flowers of *Cannabis sativa* (*Jour. Ind. Bot. Soc.*, 1925, Vol. 4, No. 6). (25) Abnormal sporophylls in the male cone of *Cycas circinalis* (*Jour. Ind. Bot. Soc.*, Vol. 4, Nos. 9 and 10). (26) The Vegetation of Western Himalayas and Western Tibet in relation to their climate (*Jour. Ind. Bot. Soc.*, Vol. 4, Nos. 9 and 10, 1925). (27) The colour in the flowers of *Potentilla argyrophylla* (*Abs. Ind. Sci. Cong.*, 1926). (28) *Salsola fœtida* with special reference to its galls (*Proc. Lahore Phil. Soc.*, Vol. 5, 1925-26). (29) Replacement of fertile shoots by vegetative shoots in *Euphorbia tibetica* Boiss. (30) A new species of *Petalophyllum P. indicum*, Kashyap, from Lahore (*Jour. Ind. Bot. Soc.*, 1928, Vol. 7, No. 1). (31) A study of *Dumortiera* (jointly with Mr. Brij Lal Sethi) (*Abs. Ind. Sci. Cong.*, Madras, 1929 ; Botany Section *As. Soc. Beng.*). (32) Observations on the flora of the Upper Chandra Valley and Spiti (*Abs. Ind. Sci. Cong.*, Madras, 1929, *As. Soc. Beng.*). (33) Some geographical observations in Western Tibet (*Jour. and Proc. As. Soc. Beng.*, 1929, Vol. 25, No. 1). (34) Liverworts of the Western Himalayas and the Panjab Plain, Part I (Panjab University Publication, 1929). (35) Liverworts of the Western Himalayas and the Panjab Plain, Part I, Supplement (Panjab University Publication, 1933). (36) Liverworts of the Western Himalayas and the Panjab Plain, Part II (Panjab University Publication, 1933). (37) The Liverwort flora of Sikkim, Read at the Ind. Sci. Cong., Allahabad, January 1930 (*As. Soc. Beng.*, Bot. Section). (38) Notes on the flora of Central Tibet, Read at the Ind. Sci. Cong., Allahabad, January 1930 (*Abs. Bot. Sec., As. Soc. Beng.*). (39) Some abnormal cones in *Equisetum debille* (*Jour. Ind. Bot. Soc.*, Vol. 9, No. 4). (40) Some peculiar cones and microsporophylls of *Cycas circinalis* (*Jour. Ind. Bot. Soc.*, Vol. IX, No. 4). (41) *Stellera chamæjasme* Linn. (*Jour. Ind. Bot. Soc.*, 1930, Vol. IX, No. 4). (42) Acrogynous Liverworts of the Western Himalayas (*Malaviya Commemoration Vol.*, 1932). (43) Some aspects of the Alpine vegetation of the Himalaya and Tibet with appendix—List of plants in the Herbarium of the Botany Department, Government College, Lahore, collected by Prof. S. R. Kashyap beyond the main Himalayan range, Pres. Address to the Nineteenth Indian Science Congress at Bangalore (*Proc. of the 19th Ind. Sci. Cong.*, 1932). (44) Autonomous movement in the leaves of *Curculigo recurvata*, Dryand. (*Current Science*, Vol. I, No. 1). (45) Some more peculiarities in the male cone of *Cycas circinalis* collected at Lahore in 1932 (*Ind. Sci. Cong.*, Patna, 1933, Abs.) (46) An account of a Journey to the Gangotri Glacier (*Urusvati Journal*, 1933). (47) Jointly with P. N. Mehra, Dichotomous branching in the leaves of *Pleopeltis simplex* Sw. (*Current Science*, 1934, Vol. III, No. 2). (48) Flora of the Central Panjab (To be published shortly by the Panjab University).

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## Dr. Ekendranath Ghosh, M.Sc., M.D.

WE regret to announce the untimely death of Dr. Ekendranath Ghosh, M.SC., M.D., Professor of Biology, Medical College, Calcutta, at the age of 50, on the 15th of October, at his Calcutta residence. Dr. Ghosh was a distinguished graduate of the Calcutta University and was appointed as the Professor of Biology in 1917. He was not only a distinguished Biologist and Physician, but was vastly read in Sanskrit Ayurveda and Hindu Astronomy and published valuable contributions in all these subjects. One of his important papers that appeared four days before his death is reviewed in another place in this issue. His death is mourned by a large circle of his friends and pupils.

# Letters to the Editor.

## Note on the Limiting Density, Mass and Temperature of Condensed Stars.*

IN a previous note[1] it has been shown that with electrons degenerate stellar matter is completely ionised for number density ~ 10 and temperature ~ 10. Thus the stability of highly condensed stars is maintained by the equilibrium between the gravitational pressure (or energy) and material kinetic and radiational pressure (or energy). Besides these, electrostatic energy is also to be introduced. While Fowler and Frenkel[2] neglect this last factor, Kothari[3] holds that this causes an appreciable increase in the limiting density. The kinetic energy of the positive ions has also been neglected by most workers. We propose to reconsider the effects of the electrostatic energy, kinetic energy of the positive ions and the radiational energy on the limiting density, and temperature of Stars.

*Electrostatic Correction.*—In the case of completely ionised atoms electrostatic energy corresponds to the total ionisation potential which has been calculated by Sommerfeld[4] for a Fermi atom. Taking the total number of atoms $n = \frac{M}{2 \cdot 5 m_H}$; M being stellar mass and 2·5 the average mol. wt. For iron atoms $E_S = 1 \cdot 597 \times 10^{14} M$. Introducing this value in the equation of equilibrium: $2T = W_S + W_G$ the kinetic energy of electrons for the non-relativistic degenerate case being taken we find that electrostatic correction is negligible as suggested by Fowler. The results are tabulated below :—

| Star | M/M | $n \times 10^{29}$ | $n_0 \times 10^{29}$ | %correction |
|---|---|---|---|---|
| Sun .. | 1 | 9·588 | 9·561 | 0·28 |
| Sirius B .. | 1·18 | 6·474 | 6·59 | 0·25 |
| Eridani .. | 2·27 | 1·744 | 1·726 | 1·04 |

*Effect of the Kinetic Energy of Positive ions.*—K.E. of positive ions $= \frac{3}{2}$ NkT = $4 \cdot 955 \times 10^{-}$T.M. Thus this is comparable to that of electrons even for $n$. If, however, equilibrium be considered at absolute zero then it is zero. Modified values of $n$ due to this are entered below :—

| Star | Temp. | $n \times 10^{29}$ | $n_0 \times 10^{29}$ | %correction |
|---|---|---|---|---|
| Sun .. | $10^6$ | 9·594 | 9·561 | 0·34 |
| Eridani .. | $10^8$ | 2·733 | 1·726 | 36·4 |
| Sirius B .. | $10^8$ | 8·106 | 6·459 | 12·5 |

*Effect of Radiation Pressure.*—As pointed by Jeans radiation pressure exerts a marked influence on the hydrostatic equilibrium especially for a condensed star. If we consider the following condition for stability $P_G + P_R \not> \frac{3}{8\pi} \times \frac{GM^2}{R}$ we can calculate the modification in the limiting density.

*Relativistic Case.*—For the relativistic case which is valid for $n >> 5 \cdot 932 \times 10^{29}$ the K.E. of electrons is $7 \cdot 243 \times 10^{-17} n^{4/3}$. On introducing this into the equation we obtain a critical mass $\frac{M}{M_S} = 0 \cdot 2787$ above which equation is not valid. Frenkel introduces the K.E. of positive ions and obtains the limiting density $\sim 10^{21}$. His method is, however, faulty as he assumes a maximum pressure $p'_0$ for the statistical distribution of positive ions given by the relation $\frac{p_0}{p'_0} = \left(\frac{n}{n'}\right)^{1/3} = Z^{1/3}$ where $p_0$ is the maximum pressure for electron distribution according to Fermi statistics. He thus tacitly assumes positive ions to be degenerate.

Modifications in the limiting density for a given star due to the K.E. of positive ions and radiation pressure can be calculated. One can also calculate the maximum temperature for a given star with given density and mass by introducing the K.E. of electrons alone or by taking into consideration the K.E. of the positive ions as well.

A. GANGULI.

College Dupleix,
Chandernagore,
*November 1934.*

* Abstract of a paper read in the Inaugural Meeting of the Indian Physical Society.

1 Ganguli, *Curr. Sci.*, Dec. 1932, **1**; 1934, **2**, 294.

2 Fowler, *M.N.*, 1926, **87**, 114; Frenkel, *Z. Phys.*, 1929, **55.**

3 Kothari, *Phil. Mag.*, 1931, **12**, 672; see also Stoner, *M.N.*, 1932, **92**, 651.

4 Sommerfeld, *Z. Phys.*, 1933, **78.**

## Formation of Hydrates and Diamagnetism.

A STUDY of the diamagnetic susceptibilities of liquid mixtures has shown that magnetic measurements are not sensitive to interaction

effects whether between like or unlike molecules carrying high dipole moments.[1] In some cases, even the formation of a compound does not affect the electronic configuration sufficiently to produce appreciable changes in susceptibility. We need cite only the cases of acetic acid and stannic chloride and of ethyl formate and stannic chloride investigated by Kido.[2] As a natural extension of these investigations, a study was made of the influence of the formation of hydrates on diamagnetism.

Cabrera and Fahlenbrach,[3] using aqueous solutions of potassium iodide observed changes in the magnetic susceptibilities due to different degrees of hydration; they also inferred that there was greater hydration at higher temperatures and that an increase of diamagnetic susceptibility resulted due to greater ionic deformation. In view of the fact that hydrates in general tend to break up on heating, such an influence is quite unlikely. This view has also been recently advanced by Tammann.[4]

Measurements on acetic acid-water mixtures failed to indicate any changes in diamagnetic values at equimolecular concentrations of the components, although a definite compound has been proved to exist particularly by Raman effect[5] and viscosity measurements.[6] As was mentioned in an earlier paper[1] in connection with acetone-chloroform mixtures, the deviation of nearly 12% observed by Sibaiya and Venkataramiah[7] seem to have also been caused by viscosity effects in their experiments.

The decahydrate of sodium sulphate was studied both in the solid state by the Curie method and in concentrated solutions by the Quincke method. When the hydrate was heated to temperatures over 33°C. (at which temperature the water of crystallisation breaks away and the salt becomes anhydrous) no change of magnetic susceptibility was observed.

Aqueous solutions of sulphuric acid, however, indicated definite deviations from additivity at concentrations of the mixture corresponding to $2H_2SO_4$, $H_2O$; $H_2SO_4$, $H_2O$; $H_2SO_4$, $3H_2O$; $H_2SO_4$, $6H_2O$ and $H_2SO_4$, $18H_2O$. The first hydrate gave an increased value while the others showed negative deviations. The deviations were of the order of 3 to 4%. These hydrates are also indicated by other physical properties such as electrical conductivity, viscosity and surface tension.

The diamagnetic susceptibilities of crystalline sulphates of Li, Na, K and Mg were determined in the solid state by the Curie method. The ionic susceptibilities of $Li^+$, $Na^+$, $K^+$ and $Mg^{++}$ calculated from the magnetic values of the hydrated salts, assuming the validity of the additive law, agree satisfactorily with the precision values of Joos,[8] Kido,[9] Ikenmeyer[10] and Pascal.[11] This suggests that the binding of the water molecules to the sulphates is very loose in contradistinction to the case of the hydrates of sulphuric acid. This conclusion receives support from the well-known fact that while sulphuric acid has a great avidity for water, the other sulphates lose their water of crystallisation very easily. Under these circumstances, the results of Ray Chaudhuri[12] seem doubtful.

It may therefore be concluded that there is not much theoretical support from these data for the concept of the enlargement of ionic radii with increased temperature in solution.

Full results will be published elsewhere.

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Annamalainagar,
*December 2, 1934.*

1 *Proc. Ind. Acad. Sc.*, 1934, **1**, 77.
2 *Sci. Rep. Tohoku Imp. Univ.*, 1932, **21**, 385.
3 *Zeits. f. Phys.*, 1934, **89**, 166.
4 *Ibid.*, 1934, **91**, 410.
5 *Ind. Jour. Phys.*, 1931, **6**, 401.
6 *Jour. Chem. Soc.*, 1909, **95**, 1556.
7 *Ind. Jour. Phys.*, 1932, **7**, 393.
8 *Zeits. f. Phys.*, 1923, **19**, 347.
9 *Sci. Rep. Tohoku Imp. Univ.*, 1934, **22**, 835.
10 *Ann. der Phys.*, 1929, **1**, 169.
11 *Comp. Rend.*, 1921, **173**, 144.
12 *Zeits. f. Phys.*, 1932, **77**, 271.

## A Preliminary Note on the Chemical Examination of the Roots of *Citrullus colocynthis* Schrader.

*Citrullus colocynthis*, called Indrāyan in Hindustani, is a plant used in medicine for a very long time. The fruit of this plant has been chemically examined by Power and Moore* in 1910. The roots are described by the Sanskrit writers as a useful cathartic in

* Power, F. B., and Moore, C. W., *Jour. Chem. Soc.*, 1910, **47**, 99.

jaundice, ascites, enlargement of the abdominal viscera, urinary diseases and rheumatism, etc. They are also supposed to have a drastic purgative action.

2 kilograms of the powdered roots were exhaustively extracted with boiling alcohol. The concentrated extract on standing deposited a white crystalline stuff, which on recrystallisation from alcohol melted at 230° C. The mother liquor was then evaporated to dryness and extracted with petroleum ether. This petroleum ether extract on concentration gave a small amount of a white sediment, which on purification melted at 68° C. From its properties and reactions it was identified as hentriacontane $C_{31}H_{64}$.

The resinous mass left after the treatment with petroleum ether, was then extracted with ethyl acetate. The ethyl acetate extract on evaporation of the solvent under reduced pressure yielded a white deposit which was filtered. On recrystallisation from ethyl alcohol it melted at 230° C. From its properties, reactions and elementary analysis it was identified as α-elaterin. This was the same stuff as that obtained from the alcoholic extract in the beginning. The percentage was 0·2 per cent. of the dried weight of the roots. (Found C=69·0, H=7·5 ; $C_{28}H_{38}O_7$ requires C=69·1, H=7·8 per cent.). The diacetyl α-elaterin $C_{32}H_{42}O_7$ was prepared in the usual way and crystallised from acetic acid. It melted sharp at 123-124°.

The brown stuff of the dried alcoholic extract, left after the removal of the α-elaterin by ethyl-acetate was then dissolved in boiling water and treated with basic lead acetate when an yellow precipitate was obtained. It was filtered, washed, suspended in water and decomposed by $H_2S$. The resultant filtrate, after the decomposition of the lead salt, on concentration, *in vacuo* gave all the reactions of the saponins. All attempts to isolate this in a pure form have failed uptil now.

The physiological properties of the drug appear mainly due to the presence of α-elaterin. A detailed account of the work will be published elsewhere.

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*November 19, 1934.*

## Mannose Dehydrogenase and Ascorbic Acid (Vitamin C).

We have for some months been carrying out an investigation on the nature of the precursor and mechanism involved in the synthesis of ascorbic acid by the rat, which is known to be independent of an external supply of the vitamins. It has been found from incubation experiments with the isolated liver, spleen and kidney tissues of the rat at 37° in a medium of Ringer-Locke solution and phosphate buffer at pH 7·4 that these tissues are able to convert mannose but not glucose, fructose, galactose, xylose and arabinose, into ascorbic acid, as determined titrimetrically.[1] Amounts of the order of 0·30—0·35 mg. of ascorbic acid have been formed from mannose per gramme of each of these tissues after 3 hours' incubation. It has been possible, further, to separate to some extent the mannose dehydrogenase system, responsible for the dehydrogenation of mannose into ascorbic acid, by extracting the acetone-dried tissues (liver, spleen and kidney) with water. The cell-free extract from liver is able to produce 0·07 mg. ascorbic acid from mannose per gramme of the tissue under the aforesaid conditions. The tissues, after being washed once with Ringer-Locke solution in order to remove the normal substrates present, are also able to synthesise ascorbic acid from mannose. The apparently specific behaviour of mannose, among the sugars studied, in this respect is under further investigation.

In contradistinction to the rat, the corresponding tissues of the guinea-pig (which is dependent on an outside source of vitamin C), both normal and scorbutic, have been found to be unable to convert mannose (or any of the other sugars mentioned above) into ascorbic acid.

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A. R. Ghosh.

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*November 28, 1934.*

## Haustorial Regeneration of Sandal (*Santalum album*, Linn) and Its Significance.

The regenerative ability of plant tissues varies with different species of plants. While some plants can be propagated only through

[1] Guha and Ghosh, *Cur. Sci.*, 1934, 2, 390.

seeds, there are others where asexual or vegetative modes of propagation are possible and offer quicker methods of establishing stocks in plantation or sylvicultural practice. They are particularly welcome in the case of slow growing species like sandal which have great economical value. Sandal lends itself to stump planting and if carried out in the monsoon season, a fifty per cent. success can be obtained.

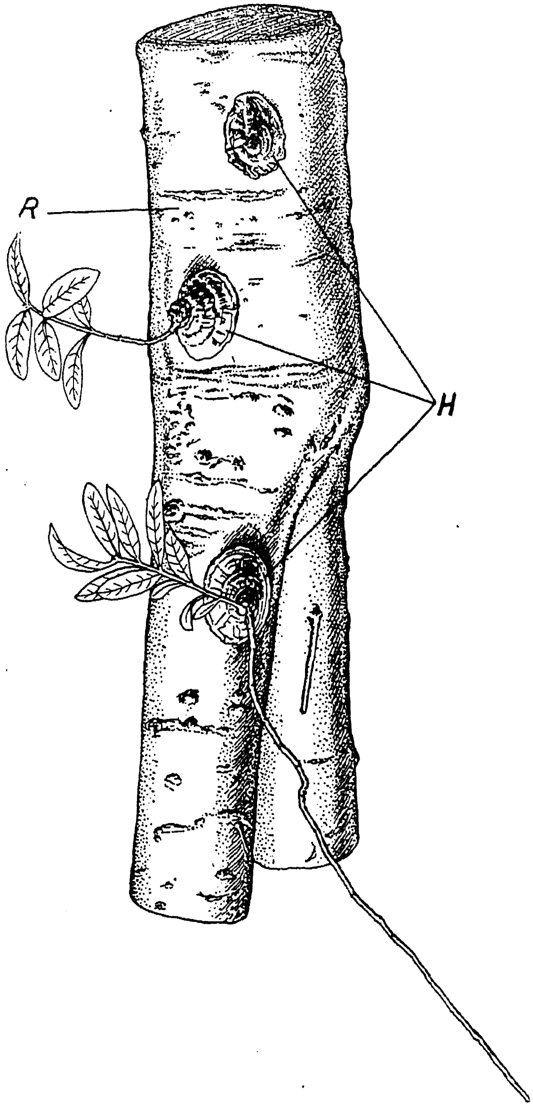


Fig. 1.

Sandal can also be propagated through root suckers; when a sandal tree is trenched at a distance of about 5 to 6 ft., it is common to find root suckers sprouting up from both faces of the trench. A larger number of them come out of the outer surface thereby indicating that a root disconnected with the parent tree is capable of regeneration. Experiments in the nursery under controlled conditions showed that one of the essential conditions that appears to be necessary for the success of such a type of regeneration, is that the decapitated root should maintain its haustorial connection with its host plant. The regenerative ability of root suckers is therefore closely associated with the haustorial connection, a fact convincingly brought out by Fig. 1, emphasising the physiological independence and parasitic character of the haustorial connection. The illustration is the drawing of a specimen of *Pongamia* root R exposed by soil erosion on the bank of a water-way near Uttarahalli. At the time of observation, the root was not in connection with any sandal plant but the haustorial connections H were intact. A few weeks later, the haustorial connections sprouted giving rise to sandal shoots.

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*December 6, 1934.*

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## Relative Parasitism of the Cotton Root-Rot Organisms from Gujrat Soils.

AMONGST the organisms isolated from affected roots of cotton, the principal ones are: (1) *Fusarium vasinfectum* form, (2) *Macrophomina* sp. (*Rhizoctonia bataticola*), (3) a species of *Cephalosporium*, and lastly, (4) a *Cephalobus* species of nematodes. Of these the *Cephalosporium* occurs rarely and there is no evidence to show that it is a parasite. The *Fusarium vasinfectum* form has been shown to be non-pathogenic. Under any circumstances this form of *Fusarium* has not given any infection and this observation has been confirmed by another worker from a wilt research laboratory to whom this form was sent. *Fusarium* obtained from Jalgaon and Broach as also the one from Desan, a village in Baroda territory, where wilt exists, gave a high percentage of infection.

It may be noted from Fig. 1 that the Desan fungus was a fresh culture (pot Nos. 3–4), whereas the fungus used in pots 1–2, 5–6 was from Jalgaon and Broach wilt areas respectively and isolated from the *gorat* soils from Baroda infected for the third time.

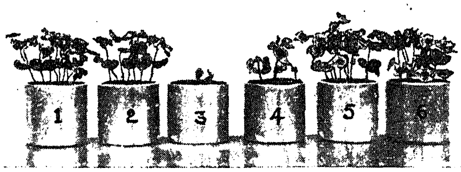


**Fig. 1.**

Infections with *Fusarium vasinfectum* form from wilt and rot soils.—(1) Jalgaon, 9 plants—3 deaths. (2) Jalgaon, 12–1, (3) Desan, 10–10, (4) Desan, 11–8, (5) Broach, 6–1, and (6) Broach, 9–0.

The fresh Desan fungus is very virulent as compared to the other two, which have lost their infective property due to their having remained for two generations in *gorat* soil.

Nematodes are generally symbiotically associated with this *Fusarium* Baroda form. No culture of the nematodes could be obtained free from the fungus although the fungus could be cultivated free from nematodes by dropping the worms in a liquid culture medium. It was thus quite probable that the existence of this *Fusarium* in affected plants was due to these nematodes.

The more closely associated rot organisms were thus the nematodes and *Macrophomina* sp., the parasitism of which could not always be induced under ordinary circumstances, although some evidence to that effect has been obtained. An interesting observation on the May and monsoon-sown cottons led to the discovery of the conditions favouring parasitism. A survey of the rot incidence made in the beginning of this Scheme on 1931-32 cotton crop from the Agricultural Experimental Station at Baroda indicated that rot occurs more extensively in the May-sown irrigated cottons as compared to those sown in monsoon after the first showers (Fig. 2).

Plot No. 22 (see graph) was sown on 15th of May 1931 and irrigated with well water seven times; this shows a rot percentage of 92 whereas with the monsoon-sown crop the percentage lies between 23 to 58. These latter plots were sown between the 18th and the 19th June, after the first showers which occurred on the 16th June 1931. Total precipitation for the year amounted to 55·60 inches. The only difference between the May and June sown crops lay in the conditions of irrigation, soil humidity and temperature. After the first showers the conditions were identical for both the crops.

Regular meteorological data were collected from April 1932 and an examination of these showed that a soil moisture of 30 per cent. and a temperature of 40° C. favoured parasitism in *Macrophomina* and *nematodes* jointly, although each one was capable of becoming parasitic under identical conditions.

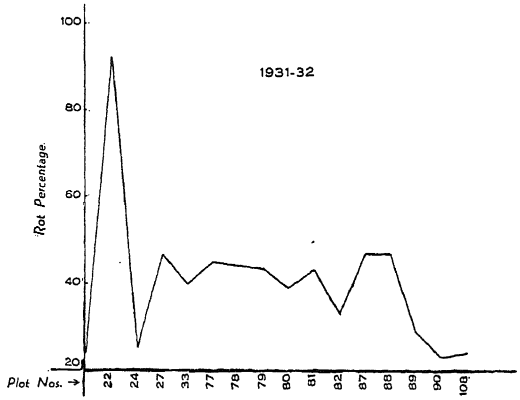


**Fig. 2.**

Experiments in which the organisms enjoyed these conditions were, therefore, planned in order to find out whether such conditions are conducive to infection. The methods employed were as follows.—

1. Roots of rot-affected cotton plants were cut into pieces, the bark being peeled off. This material was mixed up with sterilised soil and incubated for eight days after which delinted seed was sown. The temperature ranged between 38°—40° C. Within a month from sowing, out of a total of 25 seedlings 13 died of rot from which *Macrophomina* and *Nemas* were isolated. Controls from temperature tanks and rooms did not produce any deaths.

2. Roots from affected plants were chopped into pieces and mixed with sterilised soil. These were incubated for eight days in a multiple incubator with a range of temperature between 27°—42° C. Out of 41 seedlings 39 died of rot. Death roll ranged high between 30°—42° C. and isolations gave pure *Macrophomina* and *Nema* cultures.

3. Sterilised soil was mixed up with healthy cotton stalks and autoclaved. Cultures of *Macrophomina* and *Nemas* on cotton stalks were used. Infections were done with individual organisms and mixtures. Controls were kept in temperature tanks and at room temperature. The temperatures in the tanks ranged between 38°-40° C. Three out of the 15 seedlings from *Macrophomina*-pot and three out of 9 seedlings

from *Nema*-pot succumbed, and from the mixture one out of 9 died after a lapse of one month. Isolations gave identical organisms from dead plants.

4. Only *Macrophomina* was used in the same manner with two controls. Temperatures of the tanks ranged between 35°—42° C. Out of the 25 seedlings from 5 pots 14 died of rot from one tank and out of the 23 from the second tank 8 died after a lapse of one month. Isolations gave pure cultures of *Macrophomina* and there were no deaths in the controls.

The infective capacity of *Macrophomina* and *Nema* became established thus under certain temperature and humidity conditions of the soil. No sooner these conditions disappear the organisms tend towards saprophytism in the soil (see Fig. 2).

In all the above experiments water from the well with pH 8 was used. The tendency of the *Fusarium vasinfectum* form (pH 5·4) being towards acidity while that of *Nema* and *Macrophomina* was towards alkalinity as observed from cultural filtrates (pH 7·6—8·0). The soil reaction ranged from neutral to alkaline and compares with the pH ranges for the two infective organisms. The action of the irrigated water as compared to the rain water may also be taken into consideration.

In view of the results obtained, in addition to the study of resistant and immune strains to rot, control measures are being developed, involving soil disinfections, manurial and change of sowing date trials.

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*November 3, 1934.*

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### On the Introduction and Spread of *Euphorbia geniculata*, Orteg. in South India.

IN June 1933 I found several specimens of a species of *Euphorbia* growing in cultivated ground in Kengeri (9 miles from Bangalore). A little later I found the same plant growing as a weed in Bangalore. Being unable to identify it with the help of Indian floras I sent specimens to the Calcutta Herbarium and to Kew. Both Mr. Biswas and Mr. Fischer identified the plant as *Euphorbia geniculata*, Orteg. a native of Tropical America.

After making numerous enquiries I eventually came across an old gardener in the Government Gardens at Bangalore who told me that he clearly remembered that when Mr. Stephen first came to the Lalbagh he brought with him a pot of this plant and another containing a variety of *Capsicum*. Both plants grew well and set seed in Bangalore. The *Capsicum* became a popular garden plant for some years but appears to have now died out. The *Euphorbia* was also planted in gardens and soon established itself as a garden escape. Mr. Fischer tells me that Mr. John Horne Stephen came out to the Lalbagh gardens from Kew in 1891 as Assistant to Mr. John Cameron but soon left having obtained the appointment of Superintendent of the Government Gardens, Nagpur.

*Euphorbia geniculata* is a pretty plant suitable for edging in gardens although the original scarlet coloration of the leaves has been lost except occasionally when it grows in exposed situations. It produces enormous numbers of minute seeds and its spread is doubtless due to this fact. It cannot at present be regarded as a serious pest but it is becoming a troublesome weed in gardens and cultivated land.

With Bangalore as its starting point this plant has proceeded in various directions over many miles of Mysore State. It has advanced to Devanahalli on the north and to Hoskote on the north-east. On the east it has proceeded to Whitefield and on the south-east to Anekal. It has gone as far as Kankanhalli on the south and to the hamlet of Gangenhalli on the west. On the old Madras road it has reached the British town of Hosur. Last May I saw it established at Nanjangud, over one hundred miles from Bangalore. Recently it has made its appearance in the city of Madras, having established itself on a piece of vacant land near to the Government Royapettah Hospital.

The leaves of *Euphorbia geniculata* have been widely known as a purgative for many years among the poorer classes in and around Bangalore. The credit of the discovery goes to a gardener in Bangalore who in the earlier years of its introduction ate it as a pot-herb and experienced violent purging as a result. It is interesting to note that even to-day this purgative is taken always mixed with food.

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*November 19, 1934.*

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## The Original Home of *Achyranthes aspera* L.

IN a recent paper, Joshi[1] has described some variations in the behaviour of the two medullary bundles in the stem of *Achyranthes aspera* and has tried to trace the original home of the plant from the variations he observed. The latter part of the paper appeared interesting to me and I thought of putting his amazing suggestions to a test.

Twenty plants were thoroughly examined from top to base. They provided 208 internodes, each of which was cut at three places—top, middle and base. Most of the sections were examined under the microscope.

Out of the internodes examined, only 12 showed a single amphixylic bundle in the lower half, while in the upper half the two bundles were quite free. In one internode the upper half showed a single amphixylic medullary bundle, while the lower half showed two free normal bundles. In yet another internode there was a single amphixylic bundle running throughout its length.

Apart from these 14 internodes, all the rest, out of a total of 208, showed two free medullary bundles throughout their length.

Now, geographically Agra is situated between Benares and Lahore. Therefore, if Joshi's hypothesis is correct, the majority of the internodes in the Agra plants should show a fused condition of medullary bundles, which is not actually the case as the above figures show.

I may point out one probable source of error in his observations. That he did not use the microscope as frequently as is needed is amply clear from the fact that he examined most of the material "on the spot" after "cutting it with a safety-razor blade". I have observed that in a large number of cases, the medullary bundles approach each other so closely as to appear to have fused. But a section under the microscope reveals that they are free.

I have also observed the following exceptional conditions not mentioned by Joshi:

(i) Out of the two medullary bundles, one is normal while the other is amphixylic.

(ii) A single normal medullary bundle takes the place of the usual two.

In the end I would humbly submit that the facts in nature are usually not so easy to explain, and a hasty conclusion makes the confusion worse confounded. To build the whole edifice on a lean foundation is more than desirable.

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Department of Botany,
Agra College, Agra,
*October, 1934.*

[1] Joshi, A. C., "Variations in the medullary bundles of *Achyranthes aspera* L. and the original hom of the species." *New Phyt.*, 1934, **33**, 53–57.

## A Fossil Dicotyledonous Wood from Assam.

IN December 1933, Mr. C. S. Purkayastha of the Assam Forest Service sent to the Forest Research Institute, Dehra Dun, two pieces of fossil wood for identification. These he had collected from Dhansiri Reserve in Nowgong Forest Division, near Nailalung Railway Station, about 20 miles from Lumding Junction (A. B. Railway). On superficial examination both specimens were found to be secondary wood of dicotyledonous tree but entirely different from one another. The object of this note is to put on record the identification of specimen No. 2.

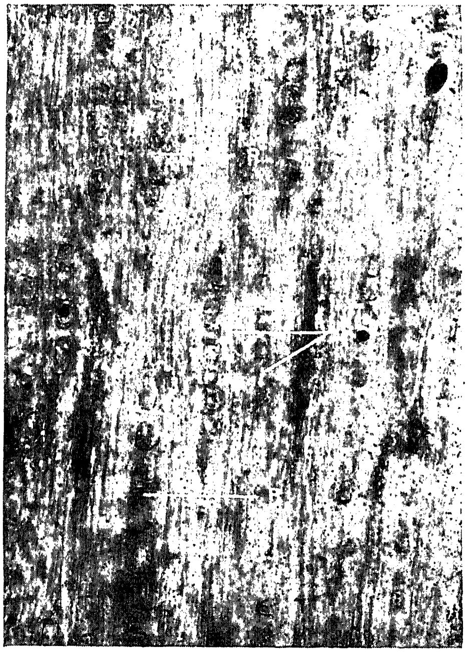

**Fig. 1.** × 150

Tangential section showing uniseriate rays (R.)

The specimen is not very large. It is somewhat circular in cross section, the diameter being 5 inches and the length

8 inches. From the look of the specimen it seems to be a portion of a fairly big trunk. Its preservation is very bad and uneven. On the longitudinal surfaces black stripes are observed indicating disintegration of the woody tissues in some places.

A good many sections (cross, tangential and radial) were cut and mounted in the usual manner. Although these sections were far from perfect, yet it was possible to find in them the minute anatomical structure essential for the identification of the wood. Moreover, macerated material

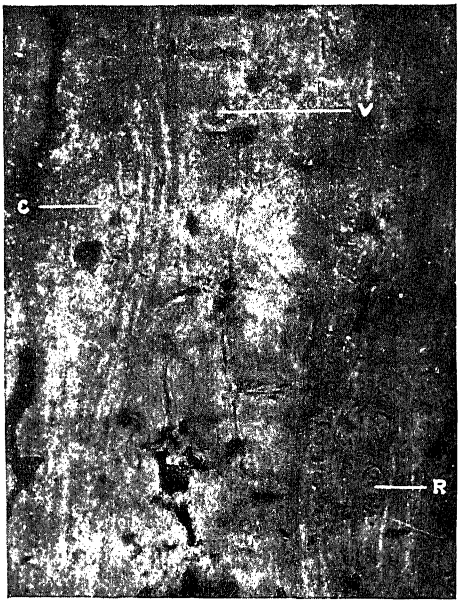


**Fig. 2.** × 230

Tangential section showing triseriated ray with resin canal (C.) in the middle, vessel (V.) with tyloses and uniseriate rays (R.)

of the wood was obtained in a sufficiently good state of preservation to enable a study of the pits on the walls of the vessels, fibres and parenchyma cells. The anatomical structure of the fossil wood may be summarised as follows :—

It is a diffuse-porous wood with mostly medium-sized vessels, which are heavily tylosed and filled with brownish deposits. Parenchyma cells are vasicentric and in narrow metatracheal bands, which may run to a considerable distance across the rays, or may end abruptly after running a short distance. The rays are of two types: (i) uniseriate, (ii) 3-4 seriate. The latter type is fusiform and contains horizontal resin canals which are rather small in size. In these features as well as in the pits, the fossil wood shows great similarity to the woods of *Gluta* species of the Anacardiaceæ. The name *Glutoxylon assamica* is, therefore, proposed. Details of the geological formation in which the fossil wood was found and a description of the minute anatomical structure of the wood itself will be published elsewhere.

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Dehra Dun, U.P.,
*October 4, 1934.*

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## Abnormal Flowers of *Cassia fistula* Linn.

AN examination of a large number of flowers of *Cassia fistula*, with a view to collecting some data regarding the occurrence of polyphylly[1] in the gynoecium of the flowers of the species, which was noted some time last year, revealed the existence of the following types of abnormalities.

1. *Median floral prolification.*[2]—In cases recorded by Masters (vegetable teratology), the prolonged axes have been terminated by a flower bud. In this case, the axis has grown into an inflorescence, bearing a number of buds in a racemose manner.
2. *Axillary floral prolification.*—A normal flower occurs in the axil of one of the anterior sepals. Associated with this is the suppression of two of the ten stamens.
3. Besides prolification, polyphylly of the various floral whorls was also met with. Polyphylly of the gynoecium (in a few cases upto seven carpels) was most frequently seen. In only one case was there a multiplication of all the floral whorls. In others, the polyphylly of any particular series (calyx, corolla, androecium, etc.) was unaccompanied by any proportionate multiplication of the rest of the floral parts.

Figures, and a more detailed account of the abnormalities will be published elsewhere.

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S. India,
*November 27, 1934.*

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1 *Polyphylly.* Members of any particular whorl are increased in number.

2 *Prolification* is the production of buds either in the centre of the flower or axillary to some of the floral leaves.

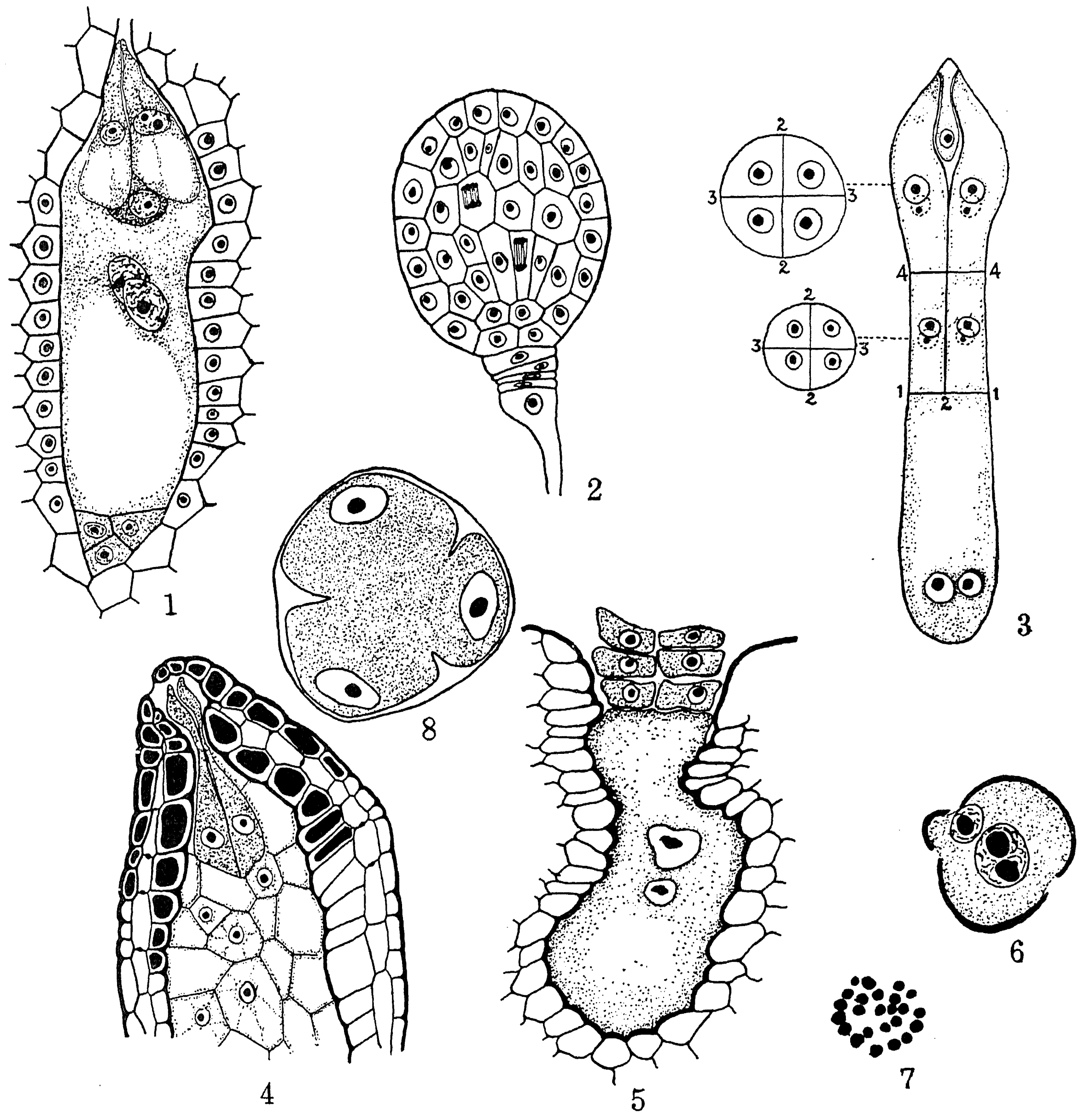
## Life History of *Herpestis monniera*

H. B. & K.

THE embryo sac of the *Scrophularineæ* is a subject of unabated interest and a large volume of literature has grown around it in recent times. On the other hand, a detailed cytological account is conspicuously absent in the available literature. The present paper represents a summary of the results of an investigation embodying the cytology of the pollen mother cell, the development of the embryo sac, embryo and endospermal haustoria in *Herpestis monniera*.

The material for study is a fairly abundant weed around water margins in Bangalore and is in flower practically throughout the year.

The meiotic phenomena in the pollen mother cell and the megaspore mother cell have been followed in detail especially in regard to the chromosome behaviour. The mode of pairing of chromosomes is found to be parasynaptic. A process of simultaneous



**Figs. 1 to 8.**

quadripartition by gradual centripetal furrowing results in the organization of the tetrads of pollen grains (Fig. 8). Twenty-four bivalents have been counted in the polar view of the heterotypic metaphase (Fig. 7). The pollen grains at the time of shedding are binucleate (Fig. 6).

The bilocular ovary is placed in a median position in the flower and has massive axile placenta bearing indefinite number of anatropous ovules all round except at the apex. The hypodermal archesporial cell is directly transformed to the megaspore mother cell without a periclinal wall. The chalazal megaspore of the linear tetrad grows into the eight-nucleate embryo sac (Fig. 1). The organization of the uninucleate embryo sac is coincident with the disintegration of the nucellar tissue. The mature embryo sac is thus in intimate contact with the innermost layer of the cells of the integument. This layer forms a nutritive tapetum and has been known as either the tapetum or epithelium.

Two male cells are organized in the growing pollen tube. Double fertilization has been observed. Syngamy is effected in a resting condition. The two polars are completely fused by the time the male nuclei are discharged into the embryo sac.

The first division of the primary endosperm nucleus is immediately followed by a transverse wall resulting in a chambered embryo sac. The nucleus of the lower chamber divides once with no wall-formation. This chamber develops into the chalazal haustorium. The upper chamber, in addition to contributing to the entire endosperm forms a micropylar haustorium with four uninucleate lobes. The micropylar haustorium is very aggressive and persists even in the seed, the tips projecting out of the integument (Fig. 4). The chalazal haustorium is short-lived and disintegrates early (Fig. 5). (The formation of the endosperm and the haustoria is indicated in diagram 3.)

A long period of rest intervenes after fertilization and when the endosperm has attained considerable dimensions the fertilized egg undergoes division. The one-celled embryo is fairly long. The embryogeny conforms to the Capsella-type with this exception that the first cell of the suspensor after giving rise to the hypophysis undergoes a number of transverse divisions. The suspensor disintegrates early (Fig. 2).

Thanks are due to Dr. M. A. Sampathkumaran for guidance and criticism.

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*November 19, 1924.*

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### Gametogenesis and Embryogeny in Some *Commelinaceæ.*

THE salient observations made by the writer on *Cyanotis cristata* Schlf., *Cyanotis axillaris* R. & S., *Aneilema spiratum* R. Br., and *Zebrina pendula* Schn. are given here, the details being treated in the full paper to be published elsewhere. Unlike in *Commelina benghalensis* Linn., none of the abovementioned plants produce any cleistogamous flowers.

A T-shaped tetrad of megaspores is formed in *Aneilema spiratum*. No wall is formed between the two megaspore nuclei in the micropylar daughter cell in the case of *Zebrina pendula*. In *Cyanotis cristata*, the mature embryo sac is restricted to an upper dome-like portion of the ovule formed by the development of a circular constriction, the micropylar collar (Fig. 2). The antipodals are ephemeral in all the plants studied. After fertilisation, the narrow antipodal end of the embryo sac of *Cyanotis cristata* pierces deep down into the nucellus as a haustorium, which is occupied by some of the first formed free nuclei of the endosperm (Fig. 2). Such a structure has not been noticed before in the *Commelinaceæ*. While the ovule increases in size, there appear four infoldings of the wall, which develop into the pits found on the seed.

The haploid number of chromosomes in the pollen mother cells is ten in *Cyanotis axillaris* and twenty in *Aneilema spiratum*. These have been determined for the first time. Size differences exist among the gemini in both the plants (Fig. 1). In the early stages of its formation, mitotic divisions take place in the tapetal periplasmodium in the anther. Needle-shaped crystals are observed in the periplasmodium when the fresh anthers are teased out. The peculiar rod-like bodies figured by Maheshwari and Singh* in *Commelina*

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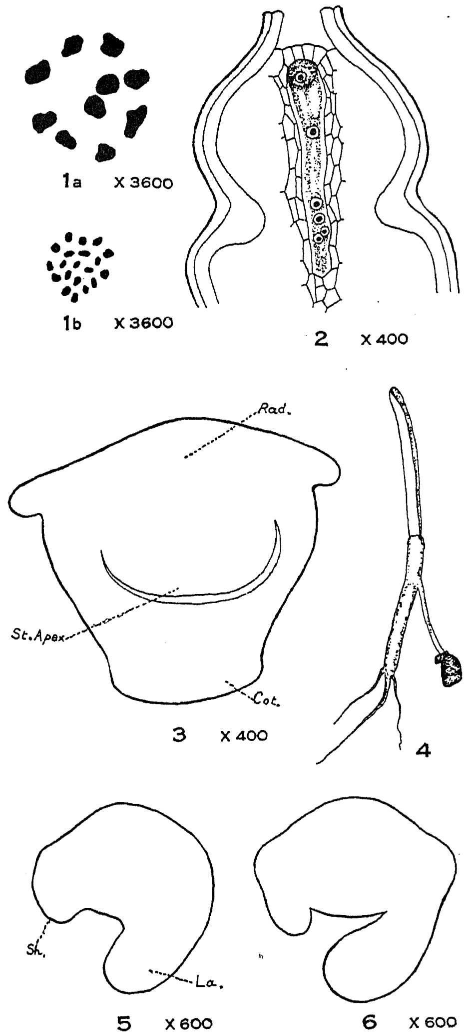
* Maheshwari, P., and Bahadur Singh, "A Preliminary Note on the Morphology of the Aerial and Underground Flowers of *Commelina benghalensis*, Linn." *Curr. Sci.*, 1934, **4**, 158-160.

*benghalensis* are not found in the periplasmodium of the plants studied by the writer. The microspores contain only two nuclei at the shedding stage. The division of the generative nucleus, which usually becomes sickle-shaped, takes place in the pollen tube.




Double fertilisation has been observed in *Cyanotis cristata*. During syngamy the male nucleus shows spireme condition of its chromatin, while the egg nucleus remains in the resting stage.

The embryo of *Cyanotis cristata* is at first merely a spherical mass of cells, thus conforming to the Pistia-type. The sheath of the cotyledon is formed early as a circular outgrowth from the peripheral zone of the apical portion of the developing embryo; the lamina of the cotyledon subsequently arises as a lateral outgrowth on the sheath (Fig. 5). The stem apex then takes its origin in the central depression of the apical or terminal portion, which alone thus forms both the cotyledon and the stem apex (Fig. 6). The growth of the cotyledonar lamina gradually extends by its lateral margins, which merge with its sheath. In the mature embryo, the cotyledon forms a complete covering over the vegetative point. The radicle is differentiated from the central portion of the broad proximal end (Fig. 3). During germination the cotyledon remains in the seed as a spherical structure, and develops a long thread-like stalk, connecting the seedling with the seed (Fig. 4).

The development of the embryo of *Cyanotis cristata* briefly described here is in accordance with the view adopted by Worsdell† for the embryo situation in the *Commelinaceæ* and the *Dioscoreaceæ*. On the other hand, Solms-Laubach‡ stated that the cotyledon is lateral in origin in the above-mentioned families.

I am indebted to Dr. M. A. Sampathkumaran under whose direction this work has been done.

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*November 27, 1934.*

## Contribution to the Morphology of *Ottelia alismoides* (Pers.).

PLANTS of the family *Hydrocharitaceæ* have received considerable attention since the time of Fischer[1] (1880), who has worked out the development of embryo-sac in *Elodea canadensis*. Particularly interesting and exhaustive among them is the work on *Vallisneria spiralis*, which is the classic example to illustrate water pollination. Recently, Rangasami[3] has worked out the complete life-history of this plant. Palm[2]

† Worsdell, W. C., "The Morphology of the Monocotyledonous Embryo and that of the Grass in particular." *Ann. Bot.*, 1916, **30**, 509-524.

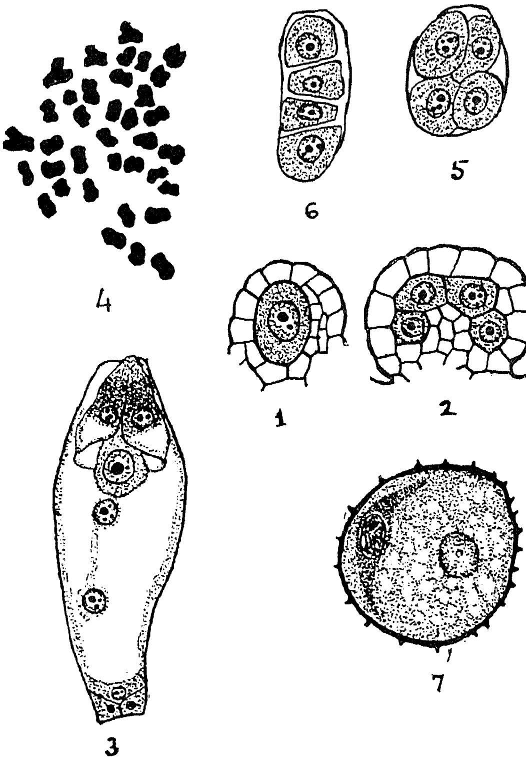
‡ Solms-Laubach, H. Grafzu, "Uber monocotyle Embryonen mit scheitelburtigen Vegetationspunkt." *Bot. Zeit.*, **36**, 1878. (Abstracted by Schnarf, K., *Embryologie der Angiospermen*, Berlin, 1929).

1-2 Extract from *Schurhoff's Die Zytologie der Bluten Pflanzen*. 1926.

3 Contribution to the Life-history of *Vallisneria spiralis*, *Journ. Ind. Bot. Soc.*, 1934.

has reported the development of embryo-sac in *Ottelia lancifolia* to be of the usual Helobiæ type. Some of the observations made below show interesting variations from the species studied by him.

*Megasporogenesis*:—Usually, there is a single hypodermal archesporial cell (Fig. 1); but occasionally it may be multi-cellular




(Fig. 2). In any case, only one develops and directly becomes the megaspore mother cell. After the usual heterotypic divisions, a linear tetrad is formed of which the chalazal megaspore develops to form a typical 8-nucleate embryo-sac (Fig. 3). The synergids are very conspicuous; each, being pyriform in shape, consists of a hyaline beak and a large vacuole at the base (Fig. 3). The egg is suspended between these two synergids. The antipodals are organised into cells (Fig. 3). The two polar nuclei are half-fused by the time the pollen tube enters.

*Microsoporogenesis*:—The earlier development of the anther is normal. The tapetum ultimately forms a periplasmodium with isolated cells. A similar case is reported by me in *Limnophyton obtusifolium* (Miq.)[4].

[4] Life-history of *Limnophyton obtusifolium*, *Curr. Sci.*, 1933, **2**, 53.

The endothecium is ill-developed. The chromosome number is 36 (haploid) (Fig. 4). The tetrads of microspores are usually isobilateral (Fig. 5), but frequently they are arranged in a linear series which is rather peculiar (Fig. 6). Another interesting feature is the structure of the pollen grain (Fig. 7). While all the members of the *Hydrocharitaceæ* so far investigated show three nuclei in the pollen grain at the time of shedding, in the case of *Ottelia alismoides* a tube nucleus and a generative cell are found.

Grateful acknowledgment is due to Dr. M. A. Sampathkumaran for helpful criticism and guidance.

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*November*, 1934.

## Specificity of Parasiticism by *Eublemma amabilis*.

IMMS AND CHATTERJEE[1] were the first to realise that "no appreciable improvement is likely to result in lac cultivation until experiments have been conducted with reference to the elimination of insect enemies." There are at once two ways open in following such an enquiry, one of eradicating the enemies, the other of making the lac insect more resistant. The former appeals to an infectionist who would argue, just as a tiger is all-powerful in comparison with a buffalo so that the latter's health cannot be given the least thought in considering its having fallen a prey to a tiger; likewise no parasite would spare a host if it is unprotected and within easy reach. He would also grant as a corollary it is not only one species but several insects which can be attacked by the same parasite if the hosts are equally weak and helpless. The other line of research would be taken up by a predispositionist who would emphasise the somatic condition of the parasitised insect as compared with an immune host. To give a concrete example Sreenivasaya[2] showed that a deficiency of Calcium in the food of the lac insect resulted in an increased death rate from parasiticism. Apart from physiological factors of predisposition

[1] Imms and Chatterjee, "Structure and Biology of *T. lacca*," *Ind. For. Mem.*, 1915, **3**, Pt. 1.

[2] M. Sreenivasaya, "The Fundamentals of intensive Lac Production," *J. Sc. Assoc.*, *Maharaja's Col.*, *Vizianagaram*, 1924, **1**, 436.

there are more subtle constitutional ones pertaining to specificity of parasiticism.

As majority of entomologists belong to the infectionistic school of thought, Imms and Chatterjee have naturally considered the possibility of alternate hosts of lac parasites and stated, "to solve this problem adequately involves an investigation of all likely coccids occurring within the lac producing areas and breeding the parasites therefrom". Following their suggestion, I actually undertook as thorough a survey of the coccid fauna of Bangalore as I could possibly make which led to the discovery of new species of lac, pseudo-lac and other scale insects. Likewise, parasites were also reared from these coccids giving rise to several new species and some new genera of chalcids. After a thorough survey I[3] concluded, "There is no danger to the lac insect in its common enemies having alternate hosts . . . . for such an enquiry . . . . gave at every step a negative result . . . . and (led) to specificity of parasiticism." Glover[4] nevertheless says, "Several (lac parasites) are suspected of parasitising also insects other than lac . . . . the alternative host forms a convenient breeding ground for the parasites." As a concrete example he writes, "*Machærola* . . . . is an alternative host for *Brasema annulicaudis*. This latter enemy not only harms lac but is also a hyperparasite of the lac friends, *Apanteles tachardiæ* and *Bracon tachardiæ*." Before Cameron, Howard had already named the same insect *Anastatus tachardiæ* which Dr. Gahan kindly points out, should be corrected to *Eupelmus tachardiæ*. Now Imms and Chatterjee had suspected it as a beneficial insect while I definitely proved it to be a parasite of *E. amabilis* caterpillars. As circumstantial evidence I[5] had mentioned that Gernet, who studied dried specimens of stick lac in Russia before 1863, was the first not only to illustrate a caterpillar of *E. amabilis* but also to give two figures of *Eupelmus tachardiæ*, How.—the close association of the host and the parasite was thereby indirectly supported. Glover takes no notice whatever of previous references and to the contrary, makes the glaring statement of having found it inimical to lac itself.

As previously remarked, factors pertaining to predisposition are constitutional and physiological. That *E. amabilis* attacks only the commercial lac insects of the genus *Lakshadia*, and never the allied ones *Metatachardia* or the pseudo-lac insects of the germs *Tachardina*, would be considered an inherent factor. That some lac colonies may escape the attack of *E. amabilis*, in a locality where this moth does occur, would not be considered merely accidental but a consequence of a physiological factor making the particular colony immune. It would be imagined that an unhealthy lac colony emits odours attractive to the parasite while a healthy one would avoid sending such suicidal messages. This is not a lame hypothesis. It was found *Lakshadia mysorensis* growing on *Acacia farnesiana* and on *Pithecolobium dulce* in the same locality, would show a far greater degree of injury on the latter or the less suitable host plant. In fact by growing a less suitable host along with the favourite tree and both infected with lac, the former would trap or attack the greater portion of the moths. Before a second generation of the parasite emerges, the crop is harvested and destroyed to prevent the parasite from breeding. This may be called a catch crop for the destruction of the parasite. Sreenivasaya and I have successfully tried this experiment at Dorsanipalya where *A. farnesiana* was grown to entrap the larger number of parasites which would otherwise all attack the lac colonies on *Shorea talura*. The colonies on *A. farnesiana* were physiologically handicapped in their race for life in order to save the colonies on *S. talura* against the aggression of *E. amabilis*.

The following experiment was undertaken to show the constitutional basis of predisposition. In a plot where *A. farnesiana* plants were growing it was found that the most common scale insect, *Anemolus indicus*, had colonised itself. Six plants were selected and divided into three pairs. One pair had *A. indicus* and *Lakshadia mysorensis* each. The second two plants had *Tachardina ternata* (brood lac imported from Travancore) and *L. mysorensis*. The last set had *A. indicus* and *T. ternata*. The plants were growing so close to each other that several branches touched one another. Branches were cut at different intervals to examine the eggs of predacious moths; on this

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[3] S. Mahdihassan, "Some insects associated with lac and a symbolic representation of their inter-relationship," *J. Sc. Assoc., Maharaja's Col., Vizianagaram*, 1925, **2**, 86.

[4] P. M. Glover, *A Practical Manual of Lac Cultivation*, Calcutta, 1931.

[5] S. Mahdihassan, same as No. 3 above, p. 76 and also reference No. 6, p. 395.

there has appeared a separate article.[6] On *L. mysorensis* eggs of *Eublemma amabilis* and of *E. scitula* were found. On *A. indicus* no *E. amabilis* had laid an egg and so was *T. terna'a* free from it; *E. scitula*, however, had attacked both these insects which it also does in nature. It would be admitted that *T. ternata* has a very soft encrustation while the skin of *A. indicus* is softer than the encrustation of *T. ternata*, thus there was no question of the hosts being mechanically protected against the weapon of attack possessed by the caterpillar of *E. amabilis*. It was a case of the sheer instinct of the female moth refusing to lay eggs on hosts constitutionally unfit to feed its progeny. It may be said finally that *E. scitula*, so rare in the forest of *S. talura*, had increased its activity when the lac insect was growing on a less favourite host, *A. farnesiana*.

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*November 1934.*

## Fruit and Seed Development of *Tinospora cordifolia*, Miers.

### EXEMBRYONATE SEEDS.

IN the August number of *Current Science* Joshi and Rao[1] published their interesting note on the Fruit and Seed development of *Tinospora cordifolia*, Miers, on which Sahni[2] has since commented. Among other things the authors report the absence of embryos in a large number of seeds examined by them, although they found the female gametophyte maturing to the normal embryosac stage, and also a copious development of the endosperm. The fruits were otherwise outwardly quite normal.

It is further reported that both pollination and fertilisation do not ensue, and the various parts of the embryosac finally degenerate, leaving only the two polar nuclei, which multiply and produce the endosperm in the absence of the "double fertilisation". The embryo, however, is not developed. Under these circumstances the authors are unable to account for the formation of "apparently normal seeds and fruits". As an alternative to the possible stimulus of foreign pollen, which was never seen, they suggest that the fruit and seed development may have been induced by the formation of the endosperm itself. This surmise is, however, not in accord with the facts already published on the subject. Moreover, they do not offer any explanation for the development of the endosperm itself in the absence of the triple fusion.

The facts communicated by the authors are by no means a rare and isolated phenomenon. In fact the case of *Tinospora cordifolia* is another illustration of what is known as *Parthenocarpy*, which has long been known, more specially in connection with the cultivated plants. It is characterised by the development of fruits without embryos. The earliest record indeed goes as far back as the year 1694 when Çamarius, as cited by Schnarf,[3] commented upon the occurrence of seedless fruits. Since then it has been discovered to be of fairly general occurrence, being found, besides numerous other plants, in oranges, grapes, bananas, figs, apples, pears, etc. In consequence of its many-sided interest, a rich literature has now grown up. This has been dealt with and summarised in the pioneer works of Molisch,[4] Fitting,[5] Tischler,[6] Winkler,[7] Schnarf[3] and Engler,[8] to which reference may be made for fuller information. Here it is only possible to refer briefly to a few facts in so far as they have a direct bearing on the note under reference.

According to Tischler the following conditions may be distinguished:— (1) Cases where a normal embryosac is developed, and (2) Cases where a normal embryosac is not developed.

The cases coming under the first category to which *Tinospora* belongs, are further characterised by :—(*a*) The ovules can develop endosperm without fertilisation, (*b*) Only the sporophytic parts of the ovule can

[6] S. Mahdihassan, "Schmetterlingsraupen als Feinde der lackschildläuse," *Natur und Museum*, 1929, **59**, 394.

[1] *Curr. Sci.*, 1934, **3**, 62.

[2] *Curr. Sci.*, 1934, **3**, 109.

[3] *Embryologie der Angiospermen*, Berlin, 1929, 547.

[4] *Pflanzenphysiologie als Theorie der Gärteneri*, Jena, 1930, 296.

[5a] *Biol. Centralblatt*, 1909, **29**. Cited by Engler in [8].

[5b] *Zeitschr. f. Botanik*, 1909, **1**, 1; 1910, **2**, 4. Cited by Engler in [8].

[6] *Jahrb. wiss. Bot.*, 1913, **52**, 1.

[7a] *Pfropfbastarde*, 1912, Jena.

[7b] *Parthenogenesis im Pflanzen u. Tier-reiche*, 1920, Jena.

[8] *Die nat. Pflanzenfamilien*, 1926, **14A**, 121, Leipzig.

undergo further development, and (*c*) The entire ovule degenerates, sometimes only after a few otherwise commonly occurring events in normal fruit formation have taken place.

As is clear, the facts described by Messrs. Joshi and Rao accord with the condition described under (*a*). Of this Tischler has investigated more closely the case of *Ficus carica* in particular. From this the following results are culled:—(1) There is complete absence of fertilisation and generally of every other external stimulus. (2) In many ovules endosperm developes into a typical nutritive tissue; in others it dies early. (3) During wall-formation an unequal number of nuclei are often enclosed in a cell. (4) Sometimes the endosperm formation does not proceed equally throughout the embryo-sac, a number of tissue-complexes being developed instead. (5) In ripe endosperm autodigestion takes place resulting in ruminate endosperm.

The results of Tischler summarised above not only agree entirely with the observations of the authors, but they are also more embracing. The authors might well revise their investigation in the light of these facts.

Other plants in which similar conditions exist are *Cœlobogyne ilicifolia*, *Dasylirion acrotrichum*, *Theobroma cacao*, *Ananassa sativa*, etc.

As for the development of the endosperm before fertilisation, to which the authors have referred, in the case of normal plants, Schnarf[3] says "Researches that in amphimictic plants the endosperm developes normally without or before fertilisation, must in general be regarded with mistrust". According to him the stimulus for the normal development of the endosperm is supplied by the second sperm nucleus. A misleading situation is often created in cases where, in spite of a normal fertilisation, the egg remains quiescent whereas copious endosperm is meanwhile developed, conveying an impression that the latter has been developed in the absence of fertilisation. A number of examples of this kind are cited by Schnarf.

The development of the endosperm, however, in parthenogenetic and parthenocarpic plants offers both unusual and interesting features. Here it is certainly developed in the absence of fertilisation. And it is now definitely demonstrated by the researches of Haberlandt,[9] Eichler[10] and others, that it is induced by necrohormones or wound-hormones in consequence of the wounding of the ovary artificially or by the action of parasitic fungi and insect-larvæ, as well as by castration. Haberlandt and his students have also demonstrated that the necessary stimulus may be supplied by the decaying cells in the neighbourhood, and even by the disorganising egg. The stimulus supplied by the entrance of the pollen tube has also been found to initiate the development of the endosperm, as also the influence of foreign pollen to which reference has been made. Even the extract of the living or dead pollen has been found to induce changes in the gynæcium.[5] Furthermore, increase of temperature, as well as osmotically active solutions of grape sugar, urea, $MgCl_2$, $KNO_3$, etc., can also cause endosperm development in the absence of fertilisation (Schnarf,[3] p. 322).

From this it is clear that the endosperm development can be brought about by a variety of causes on failure of fertilisation, and it will be difficult in any particular case to ascribe endosperm formation to any particular cause, without a series of carefully conducted experiments. In the absence of any other demonstrable cause, endosperm development in *Tinospora* may be induced by the disorganising contents of the embryo-sac itself, which the authors report.

The absence of pollination is hard to understand. Menispermaceæ are according to Diels[11] entomophilous, and in the case of *Tinospora* I myself have observed the visits of insects, including bees. A dense foliage and a distance of a few hundred feet would hardly seem to explain absence of pollination in entomophilous flowers. But this is a point on which speculation is useless.

Regarding the absence of embryos from the fossil gymnospermous seeds, Dr. Sahni

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[9a] *Sitzb. preuss. Ak.*, 1921, **40**, 695; **51**, 861. Cited by Schnarf in [3].

[9b] *Sitzb. Ak. Berlin*, 1922, **25**, 386. Cited by Schnarf in [3].

[9c] *Biol. Zentralbl.*, 1922, **42**, 145. Cited by Schnarf in [3].

[9d] *Beitr. z. allg. Bot. Haberlandt*, 1923, **2**, 1. Cited by Schnarf in [3].

[9e] *Ueber. Zellteilungshormone*, June, 1930, Scientia.

[10] *Öst. bot. Ztschr.*, 1906, **56**, 337. Cited by Schnarf in [3].

[11] *Das Pflanzenreich*, 1910, Hft. **46**, 4, 94, Leipzig.

himself has cited the case of *Ginkgo*, on the analogy of which this fact is attempted to be explained. I do not know if an answer has ever been sought in the direction of the explanations which apply in the case of the parthenocarpic plants. One should like to know if even a remote contingency of this kind can exist.

Another question that has been raised is whether *Tinospora* seed germinates at all; if not, how does the seedling arise? There do not seem to be any observations bearing on this subject. In general, the floras do not make any mention of the presence of an embryo in *Tinospora* seeds. Even Diels' monograph referred to above makes no mention of it. All that is usually referred to with reference to the contents of the seed is "glutinous pulp". From this one may presume that an embryo is perhaps never formed. The question of germination in the absence of the embryo does not therefore arise. As for the endosperm itself functioning as the embryo, there is no recorded instance, though in cases of apogamy embryos are produced by the budding of the endosperm. In any case, should an embryo be formed its presence would be detected. As is well known, this plant is multiplied vegetatively by cuttings, and this, so far as known, is the only method of propagation. It may turn out, as is frequently the case with such plants, that *Tinospora* has completely lost the power of reproduction by the functioning of its gametes, and even by the production of the embryo by alternative methods. Diœcious plants are specially liable to failure of fertilisation owing to the distribution of their sexes on separate individuals growing often wide apart, and in them therefore, the phenomenon of parthenogenesis is comparatively more frequently exhibited. This may also apply to *Tinospora*. In this connection the occurrence of parthenogenesis in another member of the family as reported by Ernst,[12] may not be without significance.

It would be extremely interesting and highly instructive to investigate the biology and life-history of this plant more thoroughly.

N. K. TIWARY.

Benares Hindu University,
*October 1934.*

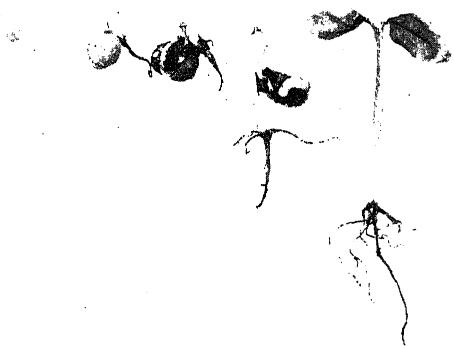
[12] *Nature*, 1886, **34**. Cited by Diels in [11].

## SEEDS AND SEEDLINGS OF *Tinospora cordifolia*, MIERS.

JOSHI AND RAO[1], in their account on the fruit formation in *Tinospora cordifolia*, Miers, have observed that the fruits develop possibly by the influence of foreign pollen and though they look apparently normal with copious endosperm, yet the seeds, it is reported, are destitute of embryos.

Sahni,[2] while discussing the possible influence of foreign pollen on fruit formation, rightly questions how the plants originate when the seeds are exembryonate.

In this note, without entering into the morphological details it is recorded that the



seeds of *Tinospora cordifolia*, Miers, though developed perhaps by the influence of foreign pollen, possess embryos which are perfectly viable. The embryo can be seen, even without the help of a hand lens, after dissecting out the ruminate endosperm with which it is surrounded. Seeds that were sown have germinated successfully. The seedlings shown in the photograph were collected soon after the rains during the month of September, from the neighbourhood of the parent plant.

The plant has been kindly identified by the Government Systematic Botanist, Coimbatore, as *Tinospora cordifolia*, Miers.

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Department of Botany,
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*December 5, 1934.*

[1] *Curr., Sci.*, 1934, **3**, 62 and 63.
[2] *Ibid.*, 1934, **3**, 109 and 110.

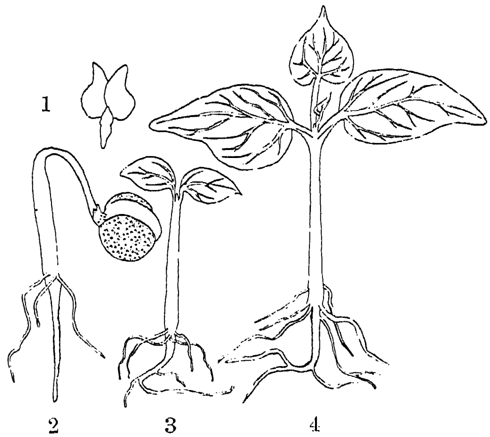
THE SEEDS OF *Tinospora cordifolia*, MIERS.

THE recent note by Joshi and Rao on "Fruit and Seed Development in *Tinospora cordifolia*, Miers, without Fertilisation and Embryo Formation inside"[1] was read by me with a certain amount of surprise. In a previous issue of this journal[2] Prof. B. Sahni has made some further remarks on exembryonate seeds and asks two pointed questions: "How does the *Tinospora* seed germinate if at all?" and (2) "Whence does the seedling take its birth?".

Joshi and Rao have omitted these points altogether and thus the latter part of their paper loses a great deal of its value and interest.

About two years ago I started some work on the morphology of this plant, the material of which had very kindly been fixed and imbedded by Mr. Babulal Gupta of this Department. Due to unavoidable circumstances I had to give up my work for some time and it is only recently that I have taken it up again.

I can definitely say that *the seeds of Tinospora cordifolia do possess an embryo and they germinate in the normal way*. The



**Figs. 1-4.**

1. Embryo dissected out of a seed soaked in water. × Natural Size.
2. Young seedling. × Natural Size.
3. Same, slightly older. × ½.
4. Young plant showing two cotyledons and 2 new leaves. × ⅜.

embryo is very hard pressed to the endosperm and is difficult to recognise as the cotyledons are very thin and their colour is the same as that of the endosperm. Fig. 1 shows an embryo dissected out of a seed.

Immediately on receipt of the paper by Joshi and Rao, I sowed 75 seeds of which 50 germinated within a week and the seedlings were entirely normal in appearance (Figs. 2, 3 and 4). Of those that did not germinate, some were dug out and on dissection an embryo was found in every one of them. This indicates that germination was merely delayed or perhaps stopped in these cases due to entirely different causes. Apart from this, I have also been able to find seedlings growing in nature.

It is true that male plants are very rare in this species and the chances of effective pollination are meagre. This merely suggests that the development of the embryo is parthenogenetic—a fact recorded for several Angiosperms and for *Disciphania Ernstii*[3] (Ernst, 1886), a member of the family Menispermaceæ itself.

It is therefore to be desired that Joshi and Rao will re-examine their preparations and remove the source of error, wherever it lies. I reserve further remarks for a future occasion.

My preparations have been examined by Dr. P. Maheshwari and I have his support for my conclusions.

BAHADUR SINGH.

Agra College, Agra,
*October 3, 1934.*

[1] *Curr. Sci.*, 1934, **3**, 62.
[2] *Ibid.*, 1934, **3**, 109.

[3] Ernst (1886) Quoted in Schnarf, K., *Vergleichende Embryologie der Angiospermen*, 1931, 73.

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WITH regard to the earlier note of Dr. Sahni[1] and the above note of Mr. Bahadur Singh, I would point out that the observations of Rao and myself do not exclude the possibility of occurrence of embryonate seeds in *Tinospora cordifolia*. As was pointed out by us, the case appears to be comparable in all essentials with what is seen in *Cycas*. We only showed that it is possible in *Tinospora* for the seed and the fruit to develop without the formation of embryo inside. The conclusion was based mostly on the study of microtome sections, and I hope after further investigation Mr. Singh would be able to agree with it. The species can be propagated either from embryonate seeds or as is the usual practice in gardens, from cuttings.

A. C. JOSHI.

Department of Botany,
Benares Hindu University,
*November 1934.*

[1] Sahni, *Curr. Sci.*, 1934, **3**, 109.

# Soil Temperatures.

BY L. A. Ramdas and R. K. Dravid,
*Meteorological Office, Poona.*

THE temperatures attained by the soil at different depths below its surface are of importance in agriculture and depend upon a number of factors, the more important of which are enumerated below:—

1. Duration and intensity of solar radiation.
2. Colour and cover (*e.g.*, vegetation) of the soil which determines the fraction of the solar radiation which is absorbed by the soil surface.
3. The thermal conductivity of the soil which again varies with:
   (*a*) the chemical composition,
   (*b*) the water content, and
   (*c*) the pore space or apparent density.
4. Air movement or convection above the soil surface.
5. Radiation exchange, especially in the long wave-length or infra-red region of the spectrum between the atmosphere and the soil surface.

An account of the heat balance at the ground surface would involve the careful measurement of the numerous factors mentioned above at a number of representative places. For a preliminary survey of this problem, however, it is possible to eliminate the variations of some of the factors and study the influence of each separately.

First of all, the variation due to climatic differences from place to place may be eliminated by bringing sufficiently large soil samples to one place of observation. N. K. Johnson and E. L. Davies[1] have measured temperatures at a depth of one centimetre in blocks of Tar, Macadam, Bare-Earth, Sand, Rubble, and Bare Clay 1 metre square and 15 cm. deep. In view of the fact that the samples were 15 cm. deep, their results may be expected to represent the joint effects of the colour and composition of the materials used.

A simpler way of arranging such experiments is outlined below:—

(1) The physical and chemical properties of the soil may be kept identical by working with blocks of the local soil in the natural condition and varying only the "cover" or surface by sprinkling a very thin layer (about 1 or 2 mm. thick) of each foreign soil over its assigned plot. Then only the "colour" or "albedo" factor varies from plot to plot.

(2) The effect of varying the physical and chemical composition of the soil may be studied by working with blocks of different soils of sufficient depth and covering the surfaces of all the blocks with the same soil, preferably the local soil.

At the Agricultural Meteorological Observatory, Poona, the first part of the above programme, *viz.*, a preliminary study of the effects of surface covers on the local soil, was commenced during the winter of 1933-34. The effects of covering the local black cotton soil with:

(i) a very thin layer of chalk powder,
(ii) a very thin layer of charcoal powder, and
(iii) wetting just the surface of the soil with known quantities of water,

was studied by taking simultaneous two-hourly readings of the soil temperature in two plots one of which was kept as the control and the other was given the treatments referred to above successively. Before commencing each experiment the two plots were kept similar for a sufficient period so as to equalise the initial conditions.

The results obtained in the case of chalk powder and watering to an extent equal to ½″ rain are shown in Figs. 1 and 2.

Figs. 1 (*a*) and (*b*) are isopleths of the weekly mean temperatures at 1400 hours in the afternoon in the control and chalk covered plots respectively. The abscissæ refer to the successive weeks and the ordinates refer to the depths below surface. The plots were similar during the 1st week. The layer of chalk powder was given at the beginning of the 2nd week and kept on during the 2nd, 3rd and 4th weeks. At the end of the 4th week the chalk coating was removed. The very conspicuous lowering of the soil temperatures during the 2nd, 3rd and 4th weeks in the experimental plot is shown by the rapid approach of the isotherms towards the surface. It is also interesting to note that it took nearly two weeks after removal of the chalk for the temperatures to equalise in the two plots.

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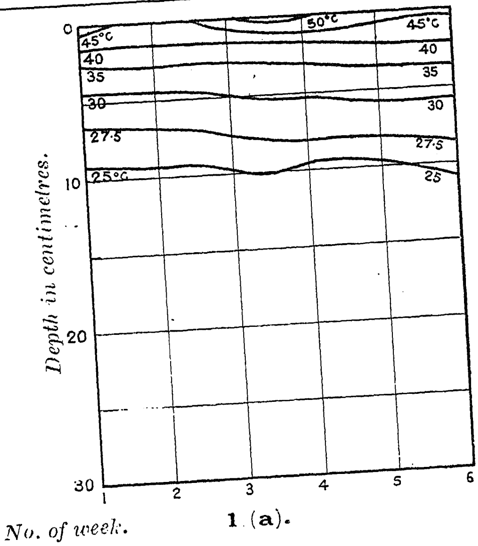
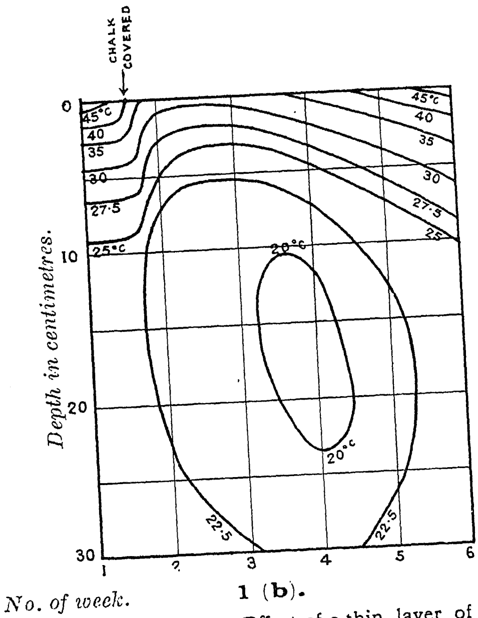
[1] *Quarterly Journal of the Roy. Met. Soc.*, 1927, **53**, 45.

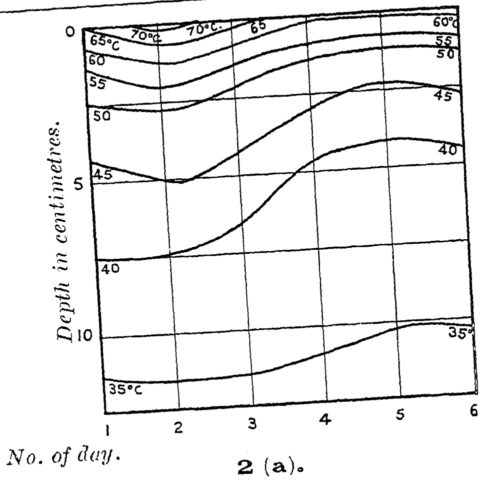



1 (a).

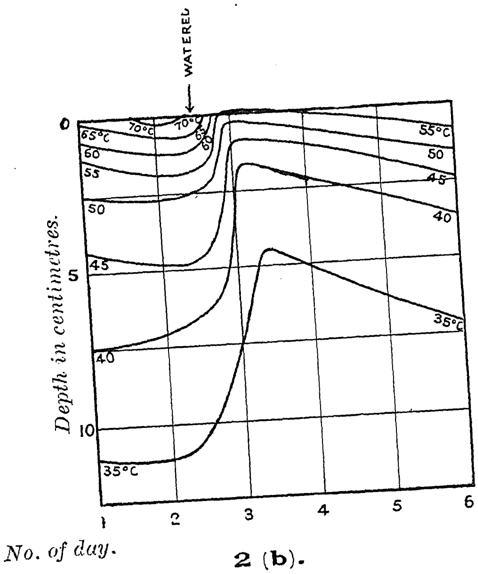



1 (b).

**Figs. 1 (a) & 1 (b).**—Effect of a thin layer of chalk powder on weekly mean soil temperatures at 1400 hrs. I.S.T. (25–12–33 to 1–2–34). (*a*) Control; (*b*) Chalk put on at the beginning of the 2nd week.




2 (a).




2 (b).

**Figs. 2 (a) & 2 (b).**—Effect of watering the surface on daily soil temperatures at 1400 hrs. I.S.T. (1–5–34 to 6–5–34). (*a*) Control; (*b*) Surface moistened on 3–5–34.

Figs. 2 (*a*) and (*b*) are the isopleths of daily temperatures at 1400 hours in the control and the surface-wetted plots respectively. The wetting was done at 6 a.m. on the 2nd day. The sudden cooling communicated to the various soil layers is clearly brought out by the rapid approach of the isotherms towards the surface on the 2nd day. The recovery from the effects of wetting was gradual and the temperatures had not yet quite equalised even on the 6th day.

The effect of covering the soil with charcoal powder was less conspicuous because the local soil is already black or nearly black in colour.

This year soil samples of different varieties of colour and texture have been secured from different parts of India and experiments with five plots are being commenced. The effect of different intensities of wetting as well as of a vegetative cover are also included in the programme.

## Entomological Investigations on the Spike-Disease of Sandal.

*Indian Forest Records. Entomology Series. Published by the Government of India, 1932-33.*

THIS is a valuable series of entomological papers issued in connection with the investigation of the entomological aspects of the spike-disease of the Sandal tree (*Santalum album*) in South India carried out by the Forest Research Institute, Dehra Dun, on behalf of the Forest Departments of Madras and Coorg in South India. The results of this investigation on sandal entomology which occupied a period of over three years from 1930 have been published in parts and so far twenty-four parts have appeared in the *Indian Forest Records* Series. Of these twenty-four papers, No. 1, part of No. 2 and No. 20 give us an idea of the history and genesis of the main problem of sandal spike-disease, the programme of investigation, the progress of the work and the final results of the investigation of the main problem of the relation of insects to the sandal tree and the part they might play as vectors of the spike-disease. The other numbers—twenty-one parts in all—deal chiefly with the systematics and bionomics of the different groups of insects collected from sandal and are papers prepared by specialists to whom the different groups of insects were submitted.

In the first number of the series, Dover gives an account of the whole problem of the sandal spike including the history of the disease, early spike investigations and their results and discusses the different possible methods of transmission of the disease and lays stress on the likely transmission of the spike-disease by insects, especially by sucking forms and the economic importance, therefore, of intensive studies on the insect fauna of the sandal areas of Salem and Coorg. In the first part of the second paper Dr. Beeson gives a short account of the genesis of this insect survey idea, describes the organisation for research on the entomological aspects of the disease and adds some remarks on the transmission experiments started in connection with it in Salem and Bangalore. In Dr. Beeson's words "The faunistic survey had as its primary objective a determination of the constitution of the sandal insect association and the regional distribution of its component species."

The other papers include studies on special groups by well-known specialists. The groups studied so far include (*a*) *Beetles* of the families *Cicindelidæ* (by Horn and Chatterjee), *Coccinellidæ* (Korschefsky), *Bostrychidæ*, *Platypodidæ* and *Scolytidæ* (Beeson), *Anthicidæ* (Heberdey), *Lycidæ* and *Brenthidæ* (Kleine), *Anthribidæ* (Jordon), *Carabidæ* (Andrewes), *Melasidæ* and *Elateridæ* (Ftentiaux), *Crambycidæ* (Fisher); (*b*) *Neuroptera* (Banks); (*c*) *Thysanoptera* (Ramakrishna Ayyar); (*d*) *Formicidæ* (Mukerji); (*e*) *Rhynchota* families—*Jassidæ* (Pruthi), *Cercopidæ* (Lallemand), *Membracidæ* (Funkhouser) and *Pentatomidæ* and *Fulgoridæ* (Chatterjee). An examination of the forms noted in these systematic papers shows a very interesting and unusual record of about 500 species of insects found on this single tree *Sandal*. Of this number, 79 forms appear to be new to science including a few new genera. Greater attention, however, appears to have been paid to the groups of sucking insects especially the homopterous families *Jassidæ* and *Fulgoridæ*, and in the series we find special monographs on the life-history and morphology of three insects—the Jassid *Petalocephala nigrilinea*, W. and the two Fulgorids *Sarima nigroclypeata*, M. and *Eurybrachys tomentosa*, F.—all by Mr. N. C. Chatterjee. The reason for the special attention paid to these three insects appears to be that these were found fairly common and injurious to sandal and were considered as probable vectors of the spike-disease. These three papers recording intensive studies on the different aspects of individual insects are extremely interesting and useful and have added to our knowledge of these bugs in many ways, as for example, in the case of two of these insects, *viz.*, *Petalocephala* and *Eurybrachys* it has been found by breeding that three described species of each of them are after all the two sexes of one of the same species! In addition, these intensive studies on particular species as types give hemipterists a general view of the life-history and bionomics of the family as a whole—a feature which is of great importance to future workers in this line. As a result of these studies on Homoptera the jassid *Moonia albimaculata* was pitched upon as the most probable vector of the spike-disease and in paper No. 20 of the series, Dover gives an account of the different series of trials such as mass infection

experiments, group experiments and specific vector experiments explaining the methods adopted and the insects utilised; he also adduces different kinds of evidences to incriminate the insect *Moonia albimaculata* as the possible vector of the disease and finally summarises the results of the experiments conducted so far by stating (1) that field investigations and biological analyses strongly support the theory that spike-disease is transmitted by insects, (2) experiments with several species of bugs appear to confirm the theory advanced that *Moonia albimaculata* is a very probable vector of spike-disease, and (3) lantana aphid (*Macrosiphum*) is also a probable vector of the disease. On the whole, it would appear from Dr. Beeson's post-script at the end of this paper that the Sandal Spike Investigation Board "is not wholly agreed that the available evidence demonstrates conclusively that spike has been experimentally transmitted by insects or that *Moonia albimaculata* is a proved vector." It would appear, on the whole, however, that the problem of insect agency in the dispersal of sandal spike is still a moot question demanding further investigations for confirmation. This is evident from further opinions of a controversial nature expressed on the subject in the columns of *Nature* (1933, p. 592), *The Indian Forester*, (1934 pp. 492 and 505) and later in this journal itself in July last.

It was unfortunate that, in the meantime, the special grant subsidising research on spike-disease expired in September 1933 and the investigations had to be abruptly closed down. In our opinion, though the transmission experiments have carried us considerably forward towards the elucidation of the ways of this mysterious disease there is still room for a good deal of further work in this direction. Speaking of the entomological aspect of the investigations we venture to think that separate observations on the insect fauna of healthy and spiked trees and data collected for each of these sets might have also helped towards the fixing of the transmitting agency to insects if the disease is really insect-borne and in the case of experiments with *Moonia* we venture to think that experiments might have been tried to feed the nymphs of the bug on the infectious material, and allow it to become an adult before it is allowed to feed on a healthy shoot instead of using the adult insect. It is perhaps likely that, as in the case of the insect *Thrips tabaci*—a well-known insect vector, for proper infection of healthy tissue—it is necessary that the young one of the insect should be fed on infectious material and allowed to grow into an adult before it is able to inoculate the toxin. In the event of this investigation being taken up again, it is hoped that this and other lines of research may be tried. It would also be advantageous if an experienced Mycologist or at least one who thoroughly knows the technique of virus studies is also associated in such experiments.

In conclusion, we might add that, whatever might have been the results of the investigations on the main problem, from an entomologist's point of view the results of these faunistic studies present a unique and very valuable contribution both from the academic and economic points of view. For, this series of insect studies, the results of the very first attempt at an exhaustive and systematic study of the insect fauna of a single forest tree in the whole of India, and as such, the insect survey papers have substantially contributed to the subject of entomology as a whole. Entomological workers in general and particularly those in South India are especially indebted to Dr. Beeson who has been mainly responsible for the initiation of these entomological investigations and his assistants Messrs. Dover and Chatterjee for gathering the bulk of the material studied and for arranging to get done this exhaustive survey of the insect fauna of sandal, thus adding substantially to our knowledge not only of the insects associated with sandal but of the insect fauna of the whole of South India. We have also to congratulate them in securing the services of well-known specialists in the different groups who also deserve our thanks.

T. V. RAMAKRISHNA AYYAR.

## Research Notes.

### Almost Periodic Functions in a Group I.

THE theory of almost periodic functions built up by Bohr, Wiener, Besicovich and others has been extended in a remarkable manner by Neumann (*Trans. Am. Math. Soc.* **36,** No. 3). The theory of representations of continuous groups developed chiefly by Weyl (for an account of the theory see Weyl 'Group Theory and Quantum Mechanics') was shewn to include the theory of periodic functions as a special case. The determination of a canonical system of representations by means of which every representation of the group can be expressed corresponds with the problem of determination of a set of orthogonal functions by means of which every orthogonal function can be expressed. The notion of almost periodicity which was defined by Bohr for the case of functions $f(x)$ which are defined in $-\infty < x < \infty$ and which are continuous has now been extended by Neumann to the case of functions defined in any group G of an extremely general type. The definition he gives is this. Let $f(x)$ be a function defined in G ($x$ denotes an element of the group) Next let M be the aggregate of all functions $f_a(x) = f(xa)$, where $a$ denotes the various elements of the group. Now given any sequence of functions $f_1, f_2, \ldots, f_n, \ldots$ of M if we can find a subsequence $f_{\lambda_1}, f_{\lambda_2} \ldots f_{\lambda_r}, \ldots\ldots$ such that the least upper bound of $| f_{\lambda\nu} - f_{\lambda\mu} | \to 0$ as $\nu$ and $\mu$ tend to $\infty$ then the function is said to be right almost periodic. In a similar manner the left almost periodicity is given.

The chief difficulty that was encountered was to find the analogue of the Bohr-mean *i.e.*, $\underset{T \to \infty}{\text{Lt.}} \frac{1}{2T} \int_{-T}^{T} f(x)\,dx$ as the groups considered are not assumed to be topological. Neumann overcomes this difficulty by defining a new mean in Part I. Neumann uses his results to deduce fundamental theorems concerning the representation of groups, which were given in case of various special groups by Weyl and Haar. It is also shewn that this theory of almost periodic functions is the widest range over which this theory of representations holds without any loss of generality. Part IV deals with the relations of this theory when the group has a topological structure and with the determination of all almost periodic functions belonging to the group. In Part V it is proved that the maximal amount exists in abelian groups (subject to certain topological restrictions). We await with great interest his further memoirs on the subject.

K. V. I.

### Asymptotic Partition Formulae III.

PARTITION into $k^{th}$ powers by Maitland Right. *Acta Mathematica*, **63,** pp. 143-91. Hardy and Ramanujan have determined the order of $p(n)$, *i.e.*, the number of partitions of $n$ by means of the celebrated method of approximating the contour integral for $p(n)$. The author here proposes to determine the orders of $p_k(n)$, *i.e.*, the number of partitions of $n$ into $k^{th}$ powers. Hardy and Ramanujan had to deal with the singularities of the elliptic modular function and the known transformation theory of the function was of great help in finding out the nature of the function near a boundary point. In the case considered by the author the generating function did not possess any general transformation theory and therefore a good deal of his paper is devoted to the development of a transformation theory of the corresponding generating function. He obtains a formula for $p_k(n)$ which generalises the Hardy-Ramanujan conjecture, *viz.*, $p_k(n) = B_0 n^{b - 3/2} e^{\Delta n^b}$ and also gives us the order of the error.

K. V. I.

### Equilateral and Equiangular Hexagons in Space (The Carbon Six Ring).

K. R. GUNJIKAR published about a year ago in the *Journal of the University of Bombay* an investigation of the construction of equilateral and equiangular polygons in space. He only considered those cases for which $n \leqslant 6$ where $n$ is the number of the sides of the polygon. It is only when $n=6$ there is any mathematical interest in the problem However the case $n=6$ is of special interest to the organic chemist. The investigation of the same problem has been recently published by P. C. Henriquez in the *Proceedings of Koninklijke Akademie van Wetenschappen te Amsterdam* on the very same lines of Gunjikar without noticing

his work. We will, however, give here the solution of the problem as given by Gunjikar. Let ABCDEF be the polygon, $\theta$ denote the complement of the angle between two adjacent sides and let $\alpha$, $\beta$, $\gamma$ be the angles made by the planes ABC, CDF and EFA with the plane ACE. (i) If $\alpha=\beta=\gamma$, $\alpha$ is imaginary for $\theta<60°$, there is one hexagon for each $\theta$ if $\theta$ lies between 60° and 120° and two such hexagons for each $\theta$ if $\theta \geqslant 120°$. (ii) If $\alpha$, $\beta$, $\gamma$ are not all equal, then $\alpha$ and $\beta$ can be determined satisfying certain conditions, if $\gamma$ is known. This is really a very interesting result. For real values of $\alpha$, $\beta$, $\gamma$, $\theta$ should be $\geqslant 60°$. If $\theta$ lies between 60° and 120°, $\gamma$ can vary between $\pm \cos^{-1}\left[\frac{4\cos\theta-1}{\sqrt{3}}\cot\frac{\theta}{2}\right]$ and if $\theta$ is greater than 120°, $\gamma$ can vary between $\pm \cos^{-1}\left(\sqrt{3}\cot\frac{\theta}{2}\right)$. Henriquez has given in his paper the above results of Gunjikar. The solutions (1) correspond to the 'non-deformable' ring and the solutions (2) correspond to the deformable ring. Henriquez has also given in his paper a discussion of the double six ring (two six rings with one side common) which is new.

N. S. N.

## The Structure of Crystals.

THE recent issue of *Zeitschrift für Kristallographie* is devoted to papers on crystal structure. The subject has become, of late, a controversial one. The controversy lies in the understanding of the nature of real crystals occurring in nature. For example, if a real crystal possesses a perfect lattice so that the crystal planes responsible for the X-ray reflection are all parallel, then the reflection of a parallel incident beam of X-rays should occur only within a few seconds of the arc in the neighbourhood of the Bragg angle. Actually it is not so. To explain this discrepancy, Darwin introduced the idea of a mosaic structure with the assumption that the crystal planes which should be strictly parallel in an ideal crystal are not so in the case of a real crystal.

Later on, other mosaic theories were formulated by Smekal and Zwicky. According to Smekal's theory, a real crystal contains many pores and cracks running throughout the crystal in a manner such that the total volume of the pores and cracks is by far negligible compared to the volume of the crystal. According to Zwicky's first theory cracks will develop in a growing real crystal due to the contraction of the surfaces which are shown to bear great stresses. According to his second theory, a real crystal is a space lattice with a secondary structure throughout the volume. According to Zwicky, the crystal with the secondary structure is more stable than the perfect crystal. The *Zeitschrift* contains two of its papers by Buerger. Buerger has levelled a caustic criticism over Zwicky's theory of the secondary structure citing many experimental evidences. Apart from his criticism, he has presented in his other paper an account of his theory of the lineage structure of crystals. According to his theory, a real crystal is a continuous one but branched. Each branch is called a lineage and each lineage is an almost straight line lattice. He shows that his theory is supported by many experimental evidences including the X-ray results. The *Zeitschrift* contains also a paper by Buckley who has criticised the existing mosaic theories. In his paper he has given a brief account of each theory and has pointed out that they need correct interpretations of experimental evidences supported by right theories. He has criticised the Darwin mosaic on the ground that it assumes inhomogeneity in a real crystal just to interpret the X-ray results while there are many more experimental facts to support the idea that a real crystal is a homogeneous one. The *Zeitschrift* contains also many more important papers by Smekal, Goetz, Taylor, James and others.

N. S. N.

## Artificial Radioactivity produced by Neutron Bombardment.

IN the *Proceedings of the Royal Society* (1934, **146**, 483), E. Fermi and his collaborators have given a collected account of the results obtained by them by bombarding various elements with neutrons. In this process new isotopes of elements have been obtained which do not correspond to known stable isotopes, but are unstable and disintegrate with definite half-value periods. This induced radioactivity was first discovered by Curie and Joliot and has been described in a previous note in this *Journal*. While Curie and Joliot used $\alpha$-particles as missiles and were thus limited to a study of the light elements only, Fermi and his

co-workers have used neutrons and have been able to observe induced radioactivity in almost all the elements with only a few exceptions. The paper contains a table at the end which gives all their results at a glance. The probable active isotope produced by the neutron bombardment, its half-value period, the intensity of the activity, mean energy of the $\beta$-rays emitted and the presence or absence of $\nu$-rays, are all listed. The presence of an active product having a half-value period of 13 minutes in the case of Uranium had been previously interpreted on the assumption that a new element of larger atomic number than 92 was responsible for this particular activity. Another component of half-value period 90 min. is also found to give reactions similar to those of the 13 min. product and both are concluded to be elements of higher atomic number than 92, probably being isotopes of one such element. The other results obtained are (1) that a large percentage of chemical elements can be activated by neutron bombardment; (2) that most of the neutrons that meet the nucleus produce an active atom; (3) that the active product is sometimes an isotope of the bombarded atom, but in other cases its atomic number is less by one or two units (the former alternative was observed with five heavy elements, while the light elements conform to the latter alternative); and (4) that only electrons have been found to be emitted under the radioactivity but no positrons have been detected. These interesting results will no doubt prove valuable for understanding the constitution of atomic nuclei.

## The Liquefaction of Helium by an Adiabatic Method.

EXPERIMENTS with liquid helium have led to discoveries of great importance such as supra-conductivity, but so far only four or five laboratories are equipped with the costly apparatus necessary for liquefying helium. Even these use a method that has a very low efficiency, *viz.*, the method which utilises the Joule-Thomson effect. It is well-known that an adiabatic expansion method would be very much more efficient, but expansion engines working at such low temperatures have not been so far designed. The piston has to be air-tight and yet move without friction—a process which is only possible when a suitable lubricant can be found. In the case of air Claude made use of the liquid air itself as the lubricant, but even such an artifice is impossible in the case of liquid helium because it would have very low lubricating properties. But Prof. P. Kapitza has now devised an expansion engine which overcomes these difficulties and can produce liquid helium at 2 litres per hour using $1\frac{1}{2}$ litres of liquid nitrogen per litre of liquid helium for preliminary cooling. The new design is fully described in *Proc. Roy. Soc.* (1924, **147**, 189). Compressed helium enters through the inlet tube into a heat exchanger A and is then cooled to 65° K. by passing round a ring-shaped container having liquid nitrogen. It then goes through another heat exchanger B to the expansion engine and thence to a third heat exchanger C and back through B to the compressor. After a few circuits the cooling is such that part of the helium leaves the expansion engine in the liquid state, but the liquid helium is not separated out in this way. Instead, part of the high pressure helium, after passing through B, goes through C where it is cooled by the upcoming helium from the expansion engine, and then passing through a fourth heat exchanger D, it passes through an orifice into the liquefaction vessel where part of it liquefies on account of the Joule-Thomson cooling. The unliquefied gas goes back through D and C and goes back to the compressor. A throttle valve is used between D and the liquefaction vessel from which the liquid helium can be drawn off. Details of the design of the expansion engine and the heat exchangers are given in the paper.

## The Statement of the Third Law of Thermodynamics.

ATTEMPTS have been made to make a simple and rigorous statement of the third law of thermodynamics ever since its formulation. One of such statements associates zero entropy with the lowest energy state (lowest quantum state). The criterion is often found to be either unnecessary or insufficient. A crystal of diamond is of zero entropy at the absolute zero of temperature, but is not in the lowest energy state. Crystalline solutions, on the other hand, are presumably in their lowest vibrational levels though the entropy cannot be taken as zero. Another statement of the third law ascribes zero entropy to a perfectly ordered

condition. Perfect order is undoubtedly a sufficient criterion though not a necessary one, as for instance, in the case of mosaic crystals, degenerate gases or electrons in metals obeying Fermi statistics. The principle of the unattainability of the absolute zero suffers from similar defects. Thus a concise statement of the third law has often proved a bit elusive.

The discussions of Eastman and Milner (*J. Chem. Phys.*, 1933, **1**, 444) and of Rodebush (*J. Chem. Phys.*, 1934, **2**, 668) make it clear that a system which is an exception to the third law (*e.g.*, glasses, solid solutions) differs significantly from other phases at the absolute zero only in the fact that the exemplars of the system differ among themselves and comprise of themselves a large number of distinguishable states. It is this indefiniteness, which is imposed by the non-selective character of the process of formation of the system that contributes towards a finite entropy at absolute zero. So it is suggested that a simple, comprehensive and sufficiently restrictive statement of the third law may be made in the form that "The entropy of any phase of sharply specifiable energy is zero at the absolute zero."

K. S. G. D.

## Cataphoresis of Proteins.

WORKERS in the field of Colloid Chemistry and allied branches of Science will be deeply interested in the contribution by Kemp and Rideal (*Proc. Roy. Soc.*, 1934, **147A**, 1-21) on the Cataphoresis of Gliadin. They have by employing the microcataphoretic method, studied the mobility of Gliadin adsorbed on a fine suspension of Quartz. The Langmuir concept of adsorption of gases by surfaces has been applied to the solid-liquid interface. The cataphoretic mobility of quartz suspension is found to be a function of the concentration of the protein. The rate of adsorption of Gliadin by quartz is found to vary with the sign and magnitude of the charge on the protein, which in turn is governed by the pH. The charge on the quartz surface, however, is shown to depend upon the ion environment and not on pH. The effect of strong electrolytes on the mobility of Gliadin adsorbed on quartz has been studied from the theoretical and practical standpoint. It has been shown that the isoelectric point of proteins is profoundly influenced by the ionic strength of the medium. The acidic and basic dissociation constants have been determined by potentiometric titrations and the isoelectric point has been evaluated. The Debye-Huckel expression for cataphoretic migration has been found to hold good for not too high nor too low ionic strengths. The deviation from the formula, for the Cataphoretic velocity of Gliadin at higher ionic concentrations (using Acetate buffers) has been shown to be due to the adsorption of acetate ions. At low ionic concentrations, Donnan equilibrium between the protein particles and the intermicellary liquid results in an unequal hydrogen-ion activity between the two phases, which in turn brings about a change in the surface charge of the proteins. The importance of these considerations in the interpretation of Cataphoretic data can thus be easily seen.

M. P. V.

## Investigations on the Nature of Hæmopoietin, the Antianæmic in Hog's Stomach.

L. KLEIN AND J. F. WILKINSON (*Biochem. J.*, **28**, 1684) in continuation of their work on the preparation of concentrates of hæmopoietin from the press juice of hog's stomach (*Biochem. J.*, **27**, 600), have come to several interesting conclusions with regard to the nature of the antianæmic factors present in stomach and liver. It is found that when concentrates of the hog's stomach extract which contain the antianæmic thermolabile hæmopoietin are incubated *in vitro* with beef muscle, a relatively thermostable hæmopoietically active substance is obtained. The product resembles very closely the active principle present in the liver and it can also be further concentrated into a form suitable for injections.

It is considered that the relationship between the antianæmic principles in stomach and liver is that of an enzyme to the end-product, the necessary substrate being provided by the constituents of beef. The action of this enzyme, hæmopoietin results in the production of an end-product which is also active in producing the red blood-cells. This latter principle is gradually stored up in the liver until it is required by the body. It is shown that this enzyme is different from pepsin because pepsin itself is not only clinically inactive but also cannot act similarly on beef muscle.

The results of Klein and Wilkinson are significant because they reveal that it is the stomach which is really the seat of the

production of the active hæmopoietic substances, the liver merely functioning as a storehouse. This observation is in conformity with the findings of Bence (*Wien Med. Woch.*, **2**, 1055) that if the stomachs of pigs were completely removed and the animals killed several months later, the antianæmic principle could not be found in the livers. In view of these findings the liver therapy in the remission of pernicious anæmia might be considerably altered.

H. B. S.

## Supplemental Light and Blooming in Tropical Plants.

THE effect of additional day length produced by artificial illumination during the winter months upon 100 species of green-house grown (chiefly annual) plants is reported by Francis Ramaley (*The Botanical Gazette*, 1934, **96**, No. 1). Among the plants which were not affected in their blooming or which were actually retarded by increased day length there is a rather large proportion of tropical species; while very few, perhaps not any, tropical species are much hastened in blooming by increased length of light exposure. Of the plants hastened in blooming by supplemental light, most are natives of the temperate zone.

## Standardization of Index Liquids.

THE identification of minerals under the microscope by making use of index liquids is becoming more and more common both among mineralogists and chemists. The liquids to be used should be colourless, chemically stable and should have as low a volatility as possible. Many mineralogists have been deterred from attempting to prepare their own set of liquids by the impression that it requires an elaborate technique to fulfil the above requirements. But J. J. Glass (*American Mineralogist*, **19**, No. 10, Oct. 1934) has shown that the United States Geological Survey prepare 50 sets of standard liquids every year. Since the determination of a large portion of minerals involves the use of liquids between 1·470 and 1·740, the three components which are made use of to prepare index liquids are Government oil (acid free, colourless, tasteless and odourless oil), monochlornaphthalene and methylene iodide. The properties of these liquids under varying conditions of temperature have been tested and it has been shown that they maintain a constant index. Since these liquids are miscible with one another, they can be conveniently used for determining the index range from 1·470 to 1·740. In further discussing the standardization of these liquids, he has shown that by using the prism designed by C. S. Ross, a chart can be prepared showing the relationship of angle of minimum deviation and the desired index of refraction. Since some of the liquids that are used at the present time are likely to change their properties including refractive index, when exposed to light and air, the suggestion of J. J. Glass might be usefully tried in geological laboratories.

## Differentiation in Basalt Lava.

A DETAILED petrological study of plateau lavas of Antrim by S. I. Tomkeieff (*Geological Magazine*, No. 845, Nov. 1934) has revealed that the vast area of basalt covering nearly 1,550 square miles can be divided into two sets—the lower and the upper—separated by an inter-basaltic bauxito-lateritic zone. The lower layer is made up of olivine basalt (dolerite), a typical representative of hebridian plateau magma type. The upper layer is made up of two contrasted types, *viz.*, the Tholeiitic type (Non-porphyritic central magma type) and olivine basalt (dolerite) same as the lower lavas. These lavas are packed with zeolites and the most prominent of them are thomsonite, chabazite, levynite and gmelinite. The rocks have been analysed which show a gradual increase in the Niggli values of fm, mg, and k downwards and a decrease in al, c, alk. From this important observation Tomkeieff has been able to show that there was gravitational sinking of olivine without remelting. This is further supported by the occurrence of idiomorphic grains of olivine in the lower zone as contrasted with the allotriomorphic relationship of this mineral with the felspar in higher zones. He has further shown that this sinking of olivine was accompanied by rise of volatiles which is responsible for the formation of abundant zeolites. Since a great portion of the basalt is of the vesicular variety full of zeolites, he has suggested that the lava contained a considerable quantity of water.

## Asphyxiation of Air-breathing Fishes of Bengal.

THE last number of the *Journal of the Asiatic Society of Bengal* (October 1934, **29**, No. 4, pp. 327-332) contains an account of "An Experimental Study of the Asphyxiation of some Air-breathing Fishes of Bengal" by the late Dr. Ekendranath Ghosh. The air-breathing fishes of India, such as *Amphipnous cuchia*, *Clarias batrachus*, *Heteropneustes fossilis*, *Ophicephalus* spp., *Anabas testudeneus*, *Fluta alba*, etc., etc., have, since a very early time, been the subject of considerable biological, experimental and morphological investigation. Usually a small vessel was used for experimental work, but Dr. Ghosh used a large tank for his experiments and thus reduced considerably the chances of the water becoming foul. He found that in his experiments most of the fishes (*Anguilla anguilla*, *Clarias batrachus*, *Ophicephalus striatus*, *O. punctatus*) survived under water for much longer periods than was hitherto possible, while *Heteropneustes* (=*Saccobranchus*) *fossilis*, *Mastacembelus pancalus*, *M. armatus* and *Rhynchobdella aculeata* could not be 'drowned'. In view of these results the author concludes that the "fish in the earlier experiments were asphyxiated as a result of insufficiency of normal water rather than for want of free air for aerial respiration". Dr. Ghosh has thus thrown considerable light on the bionomics of the air-breathing fishes of India and has shown that in experimental work on the air-breathing fishes all possible sources of errors should be eliminated to obtain satisfactory and reliable data.

S. L. H.

## The Structure of the Corpus Luteum in Lower Vertebrates.

J. T. CUNNINGHAM AND W. A. M. SMART have examined the condition of the ovary in the Amphibia and the reptiles after ovulation induced by the injection of anterior extracts (*Proc. Roy. Soc. Lond.*, Nov. 1934, **116**, No. 798). It is seen that in *Xenopus*, where alone ovulation occurred after injection, the follicle cells were rapidly absorbed and no corpus luteum was formed. In *Lacerta*, chosen as a type of oviparous lizard, the same result is seen while in the viviparous lizards like *Anguis* and *Zootoca*, a distinct and well-developed corpus luteum is seen, comparable with that in mammals. The functions of the corpus luteum in various vertebrates are also discussed.

## The Brain of *Echidna aculeata*.

A. A. ABBIE has made a signal contribution to our knowledge of the mammalian brain in his work on *Echidna* (*Phil. Trans. Roy. Soc. Lond.*, 1934, **224 B**, No. 509). Working under the direction of Prof. A. Kappers, the foremost authority on the structure of the mammalian brain, be has emphasised the primitive characters of the brain of *Echidna* and shown its similarities with its ally, *Ornithorhynchus*. The brain of *Echidna* is typically mammalian but the primitiveness of some of its traits is undoubted. The motor system, the dorsal situation of the nucleus ambiguus, the hypoglossal nucleus and the facial nucleus and the small pyramidal tracts are all primitive features. The hypertrophy of the trigeminal apparatus is a feature which *Echidna* shares with *Ornithorhynchus*. Indeed, in the latter there is a more pronounced development of this system. This has brought about a great expansion of the ventral nuclei of the thalamus. The cochlear connections are not well developed. The cerebellum is very greatly specialised; the cerebral peduncles are large but have no fronto-pontine tracts, a character with which *Echidna* agrees with *Ornithorhynchus* but differs from all other mammals. The presence of a temporo-trigeminal tract is peculiar to *Echidna*. Another primitive trait is the rudimentary fornix-mamiliare-thalamic system. The epithalamus is well developed and is connected with the pars medius of the ventral nucleus of the thalamus.

## Embryology of a Psocid.

W. FERNANDO in an interesting paper (*Quart. Journ. Micros. Soc.*, 1934, **77**, Pt. 1) described certain features in the development of the viviparous insect, *Archipsocus fernandi*, n. sp. The author points out that the yolk cells and the chorion are wanting. The ventral plate resolves itself into a median and two lateral plates. The former gives rise to mesoderm while from the latter the ectoderm is derived. The anterior and posterior rudiments give rise to endoderm. The usual insectan larval envelopes like the amnion and the serosa are formed.

# The Chemical Nature of Enzymes.

By K. Venkata Giri, M.Sc., A.I.I.Sc.
*Department of Biochemistry, Indian Institute of Science, Bangalore.*

THE study of the chemical nature of an enzyme may be approached by both direct and indirect methods. The direct method of investigation consists firstly in obtaining an enzyme preparation freed as far as possible from associated impurities and subsequently in submitting the purified product to qualitative and quantitative chemical analysis. Among the indirect methods may be mentioned (1) observations on the inactivation of enzymes;[1,2] (2) attempts to alter the structure of the enzyme molecule by treatment of the enzyme preparation with reagents specific to certain chemical groups, and the examination of the influence of such treatments upon the activity;[3] (3) observations upon physico-chemical behaviour which, in some cases, have yielded very interesting confirmations of the findings of the more direct methods.[4,5,6]

In spite of the several efforts to purify enzymes by adsorption methods, first introduced by Willstätter, no success has so far been attained in identifying any of the known enzymes as a chemical individual. The view of Willstätter that an enzyme consists of a colloidal carrier and one or more chemically active groups, is supported by observations on the behaviour of enzymes and enzyme-like substances of known structure; the colloidal carrier determines the stability and the magnitude of the catalytic activity of the active groups, the latter being responsible for the specificity of the enzymes. Thus, the oxyhæmoglobin crystals isolated from the blood of different animals exhibit quantitative differences in their peroxidase activity, such differences being due to the association of the same active iron bearing dyestuff (hæmin group) with different globin complexes acting as carriers[7] and the water-soluble lyochromes the flavines, newly isolated by Kuhn, Warburg and their collaborators[8] which constitute vitamin $B_2$ and exhibit enzymic activity by their combination with a colloid carrier, afford typical examples of the composite nature of enzymes.

In recent years, the significance of the protein nature of enzymes has become the subject-matter of fruitful discussion between American workers on the one hand, and Willstätter and his colleagues in Germany, on the other. While Willstätter and his co-workers succeeded in obtaining protein-free preparations of saccharase,[9] amylase,[10] pepsin,[11] and urease,[12] the American workers have been equally successful in obtaining highly active preparations of a predominantly protein character. The isolation of urease by Sumner,[13] pepsin by Northrop,[14] trypsin by Northrop and Kunitz,[15] chymorypsin by Kunitz and Northrop,[16] amylase by Caldwell, Booher and Sherman,[17] and lipase by Baman and Laeverenz[18] in the form of crystallised proteins may be mentioned among the important preparative successes. But the question whether the protein forms an indispensable constituent of the enzyme molecule still remains unsettled.

Several important papers on the chemical nature of amylase have recently been published. The protein nature of pancreatic amylase postulated by Sherman and his co-workers[19] has been questioned by Willstätter and his associates[10] who obtained highly active protein-free preparations through adsorption methods. In the case of vegetable amylases, the chemical nature of the enzyme is far less decisive and consistent.[20] The author[21] has recently reported the isolation from sweet potatoes by repeated adsorption on alumina gel, elution and dialysis, of a very active amylase preparation, free from proteins and has thus shown that the enzyme is neither a protein nor contains protein as an essential constituent.

*References.*

[1] Tauber, H., *J. Biol. Chem.*, 1930, **87**, 525. [2] Giri, K. V., *J. Indian Inst. Sci.*, 1932, **15A**, 117. [3] Herriott and Northrop, *J. Gen. Physiol.*, 1934, **18**, 35. [4] Sherman, Thomas and Caldwell, *J. Amer. Chem. Soc.*, 1924, **46**, 1711. [5] Stern, *Zeitschr. f. Physiol. Chem.*, 1932, **208**, 86. [6] Kubowitz and Haas, *Biochem. Z.*, 1933, **257**, 337. [7] Willstätter and Pollinger, *Zeitschr. f. Physiol. Chem.*, 1923, **130**, 281. [8] Kuhn, R., *Chemistry and Industry*, 1933, **52**, 981. [9] Willstätter and Schneider, *Zeitschr. f. Physiol. Chem.*, 1923-24, **133**, 153; 1924-25, **142**, 257. Willstätter, Schneider and Wenzel, *Ibid.*, 1925-26, **151**, 1. [10] (*a*) Willstätter, Waldschmidt-Leitz and Hesse, *Zeitschr. f. Physiol. Chem.*, 1922-23, **126**, 143; 1924-25, **142**, 14. (*b*) Waldschmidt-Leitz and Reichel, *Ibid.*, 1932, **24**, 197. [11] Willstätter and Rohdewald, *Zeitschr. f. Physiol. Chem.*, 1932, **208**, 258. Waldschmidt-Leitz and Ko Franyi, *Naturwissen*, 1933, **21**, 206; Dyckerhoff and Tewes, *Zeitschr. f. Physiol. Chem.*, 1933, **215**, 93. [12] Waldschmidt-Leitz and Steigerwald, *Zeitschr. f. Physiol. Chem.*, 1931, **195**, 260;

1932, **206**, 193. [13] Sumner, *J. Biol. Chem.*, 1926, **69**, 435; **70**, 96. [14] Northrop, *J. Gen. Physiol.*, 1931, **13**, 739. [15] Northrop and Kunitz, *J. Gen. Physiol.*, 1932, **16**, 295, 323, 339. [16] Kunitz and Northrop, *Science*, 1933, **78**, 558. [17] Caldwell, Booher and Sherman, *Science*, 1931, **74**, 37. [18] Bamann and Laeverenz, *Zeitschr. f. Physiol. Chem.*, 1934, **223**, 1. [19] Sherman and Schleisinger, *J. Amer. Chem. Soc.*, 1915, **37**, 1305; Sherman, Caldwell and Adams, *Ibid.*, 1926, **48**, 2947. [20] Sherman, Caldwell and Doebbeling, *J. Biol. Chem.*, 1934, **104**, 501; Fricke and Kaja, *Ber.*, 1921, **57**, 310. [21] Giri, K. V., *Biochem. Z.* (In press.)

# Diffraction of Matter.*

By Dr. S. Ramaswamy, B.Sc., Ph.D.

MATTER is built up of two types of entities called "Electrons" and "Protons," the behaviour of which in large-scale electric or magnetic fields can be explained satisfactorily by assuming them to be particles with definite mass and electric charge subject to the ordinary laws of mechanics. But phenomena like spectral emission and the photoelectric effect cannot be explained on these lines. The new mechanics developed by De Broglie, Schrödinger, Heisenberg, Born and Dirac leads to the same result as classical mechanics in large-scale phenomena and, at the same time, solves the problems of atomic mechanics. In this new treatment called Wave Mechanics, a beam of electrons is represented by a wave train with a wave-length $\lambda = \frac{h}{mv}$ where $h$ is Planck's constant, $v$ is the velocity and $m$ the mass of the individual electrons. The knowledge of the position of the electrons is represented by a "wave packet" or group of waves.

If electrons can be treated as waves, they ought to be diffracted by a lattice like the regularly arranged atoms in a crystal in very much the same way as X-rays and light. This was verified experimentally by G. P. Thomson, and Davisson and Germer almost simultaneously in 1928.

G. P. Thomson allowed a fine pencil of cathode rays from a discharge tube to pass through a very thin film of gold and then fall on a photographic plate. The apparatus was kept completely evacuated in order to prevent absorption of the electron beam. A ring pattern was produced on the photographic plate showing that the electron beam had been diffracted by the polycrystalline gold film. The wavelength calculated by assuming the lattice constant of gold agreed with that obtained from the relation $\lambda = \frac{h}{mv}$. This phenomenon of diffraction of electrons offers a method which has been successfully employed for the investigation of the structure of thin films, surface phenomena, the nature of polished surfaces and other allied problems.

Davisson and Germer used slow electrons from a hot filament, speeded up by applied potentials of between 60 and 600 volts, incident on one of the faces of a single crystal of nickel, the diffracted beam being detected by a moveable Faraday chamber. The position of the diffraction maxima was not quite what should be expected from theory. This discrepancy can be explained by assuming an "internal potential" for the crystal. This internal potential is found to be related to the electrical conductivity and is about 16 volts for nickel.

A fast electron beam falling on a small single crystal gives rise to an extended pattern of diffracted beams very much similar to those obtained with "crossed gratings" and monochromatic light. Using a thin sheet of mica, Kikuchi obtained a pattern similar to what would result from a two-dimensional grating of the type of a single sheet of atoms in the crystal. Condition for interference depends on two factors, the first of which is responsible for the cross grating effect and determines the position of the spots. The other factor depends on reinforcement of waves coming from points in a vertical row and the diffraction spots will be strong if this is strong and weak if this is weak. The second factor is obviously very small for extremely small crystals and comes into play for thicker crystals. The pattern obtained changes accordingly with the thickness of the crystal. Besides these factors the interaction of the incident and diffracted beams of electrons, which is absent in the case of X-rays, has also to be taken into account for a rigorous explanation of these facts.

Electron diffraction offers an excellent weapon for the study of the structure of free molecules, *i.e.*, molecules in the gaseous state. X-ray analysis of crystals sometimes leads to the determination of the structure of molecules forming the crystal. But the method is laborious and depends on tiresome elimination of all interference phenomena arising from crystal symmetry. The molecules in gases and vapours, however, are sufficiently independent of one another to ascribe the intensity distribution obtained definitely to "intramolecular" interference unadulterated by "intermolecular" effects. Using a fast electron beam and a jet of vapour Wierl has studied the structure of $CCl_4$ and other tetrachlorides. The distances between carbon atoms obtained agree with those calculated from X-ray data. Electron diffraction thus offers a powerful weapon for testing molecular models.

Electron diffraction is a new method of analysis and the exploration of its possibilities is still in its initial stages. This is merely an attempt to give typical illustrations of the interesting effects produced by the diffraction of material waves.

* Abstracted from a lecture delivered under the auspices of the South Indian Science Association, Bangalore, on 10th September 1934.

## Science Notes.

A New Species of *Indobatrachus* from the Frog beds of Worli Hill, Bombay.—In a recent communication sent to us, Mr. G. W. Chiplonker (of the Geology Department, Benares Hindu University) records the occurrence of a new species of *Indobatrachus* from the Eocene fresh water beds of Bombay island. The author points out that this new species differs from *I. pusillus* (Owen) in several respects such as the ratio of the length of the vertebral column to that of the pelvis, the ratio of the femur to that of the tibia, the ratio of the length of the hind limbs to that of the body, etc. The new species is proposed to be called *Indobatrachus trivialis*.

* * *

*A Portable Electroscope for ascertaining the Radioactivity of Spring Waters, natural gases and minerals.*—An ordinary monthly meeting of the Asiatic Society of Bengal was held on Monday the 3rd December 1934, when several interesting papers were read and discussed. Mr. Cyril S. Fox described and exhibited a field Electroscope which he employed for the examination of several mineral and thermal springs in Abyssinia. "The normal procedure is to take a definite quantity of the spring water and after strong agitation in a special vessel the gas evolved is passed into a suitable chamber in the electroscope. The natural leakage of the apparatus having been previously determined the rate of fall of the leaf due to the introduction of the radon forced out of the water is next taken. The difference is due to the radon and this compared with a standard gives the radio-activity of the water in terms of radium.

"There are naturally a number of corrections and other calculations to be made before the final estimate is obtained, but for this field apparatus these are reduced to a minimum by the design of the vessels and electroscope employed. The investigation so far as the author knows is the first of its kind outside Europe and no instrument of this type is available in England or India at the present time.

"It may be mentioned in passing that very hot springs are not likely to contain radon as the gas is not retained by the water if the temperature exceeds 150° F. On the other hand, true radium carrying waters are very rare because radium salts are relatively insoluble and are precipitated as the water cools."

* * *

*Textile Research at Calcutta.*— Dr. S. G. Barker, who recently resigned his post as Director of Research to the British Wool Industries Research Association, has been invited to organise a branch of textile research at Calcutta. Dr. Barker is one of the best known amongst those who have harnessed scientific research for the improvement of industrial processes and his investigations at Torridon have proved to be of the greatest benefit to the British Wool Textile trade.

* * *

*The British Industries Fair, 1935.*—The next British Industries Fair will open in London at Olympia and the White City on Monday, the 18th February 1935, and will close on Friday, the 1st March 1935.

The Indian Trade Commissioner in London has decided to participate in this Fair and intends to display a representative collection of Indian produce and manufactures of commercial importance and possibilities.

Firms wishing to exhibit their products at this Fair should communicate with the Indian Trade Commissioner. "India House", Aldwych, London, W.C.2, who will be pleased to make arrangements for their display on the Indian Stand.

As the Fair is attended in large numbers by buyers from most parts of the world, the exhibits are likely to receive wide-spread notice which may lead to satisfactory business connections. Book lets and show-cards relating to the Fair have been received from His Majesty's Trade Commissioner in India, Calcutta and may be seen in the Commercial Library and Reading Room at 1, Council House Street, Calcutta. (*The Indian Trade Journal*, 1934, **115**, 787.)

* * *

*Third International Congress of Soil Science, Oxford, England, July 30th—August 7th, 1935.* The Congress will be held by the International Society of Soil Science, under the general patronage of the International Institute of Agriculture, Rome, and is open to all interested in Soil Science, Agriculture, Forestry and allied Sciences. It will be followed by an excursion through Great Britain, in which all who attend the Congress are invited to take part.

Meetings of the General Committee of International Society of Soil Science will be held on the afternoon of Monday, July 29th, 1935, and on the morning of Tuesday, July 30th. The Inaugural Session of the Congress will be held and the Presidential Address will be given on the afternoon of Tuesday, July 30th. The Closing Session will take place on the afternoon of Wednesday, August 7th.

The Congress will meet as a whole at plenary sessions, and in sections at separate or joint sessions of the different Commissions through which the work of the Society is conducted. The subjects which will be dealt with by the Commission are: (1) Soil Physics, (2) Soil Chemistry, (3) Soil Microbiology, (4) Soil Fertility, (5) Soil Genesis, Morphology and Cartography, (5*a*) Alkali soils, (5*b*) Forest soils, (6) Application of Soil Science to land amelioration, (6*a*) Peat soils.

Plenary Sessions will be held on the mornings of July 31st and August 1st, 2nd, 5th, 6th and 7th. One Plenary Session will be conducted by each of the six main Commissions of the Society; at each Plenary Session, recent advances in that branch of Soil Science covered by the work of the Commission concerned will be reviewed in relation to Soil Science as a whole. A number of excursions of both scientific and general interest will take place on Saturday, August 3rd, and Sunday, August 4th.

* * *

It is understood that the *Fourth British Empire Forestry Conference* which was to have been held in 1933 but which was not held owing to depressing economic conditions will be held next year in South Africa, provided there is a reasonable prospect of the various parts of the Empire being well represented. The previous three Conferences

were held in London in 1920, in Canada in 1923 and in New Zealand in 1928. The fifth Conference, which is held once in a quinquennium, is to come off in 1940 and will be presumably invited to India, announcement to which effect was made by the Indian Delegate Sir Peter Clutterbuck, at the last Conference in Australia.

* * *

*Royal Institute of Science, Bombay.*—A Scientific Exhibition in aid of the Special Appeal Fund for Bombay Hospitals was opened in this Institute on the 13th of December, under the patronage of His Excellency the Governor of Bombay and continued for 5 days.

* * *

We are in receipt of the third issue of the *Royal Institute of Science Magazine*, Bombay, and we welcome it. Started "to seek out the causes of things" the *Journal* abounds in interesting articles on subjects like Heavy Water, Heavy Hydrogen, Wireless, etc. The editorial chat begins with an account of the part that the staff members of the Institute played during the Science Congress held in Bombay in January 1934 and ends with a list of original publications from the Institute. Judging by the numbers of papers, the Chemistry Department is very active while its sister departments like Physics, Botany and Zoology are also active. We wish the *Journal* a life of active useful service for the cause with which it was started.

* * *

*Meteors and Meteoric Iron in India.*—Mr. Mohd. A. R. Khan, A.R.C.S., B.Sc., F.R.A.S., Principal, Osmania University College, Hyderabad, in the course of the Presidential Address delivered before the meeting of the Hyderabad Science Association, on 14th July, gave a brief account of the main facts concerning meteors and meteorites with special reference to meteoric iron in India. An abridged text of the address has recently been published in the form of a pamphlet, which makes a very interesting reading. As a member of the Society for research on meteorites and a modest collector of the interesting objects himself, his address bears a stamp of authority and we feel sure that the pamphlet would be widely read and appreciated.

The account of the iron meteorite that fell in the reign of Jehangir (described on pages 12-14) may perhaps induce some enthusiastic readers to inquire about the two swords that were made from it, in responsible quarters.

Needless to say that any authentic information bearing on the subject either of unrecorded meteorite falls, or of the two swords above referred to, or in fact, of any other article manufactured from an iron meteorite in India, will be most gratefully acknowledged by the author.

* * *

*Lanolin Rust Preventers.*—Engineering Research Special Report No. 12, (2nd Edition). His Majesty's Stationery Office. The original edition of this report being nearly exhausted a second edition has been prepared. A considerable amount of further information is now available. In particular, 'life' tests extending over a period of five years on articles coated with recommended lanolin mixtures have been completed, and have given full proof of the protective value of the material. The new edition gives a complete account of the investigations undertaken together with the confirmatory tests carried out and the opportunity has been taken to include certain further recommendations which are considered desirable.

* * *

We are happy to felicitate Dr. Bawa Kartar Singh, I.E.S., on his being appointed Principal, Ravenshaw College, Cuttack. Prof. Singh was born in 1886 at Vairoval, Amritsar. He graduated in 1903 and after four years of post-graduate research work at London and Cambridge, he returned to India and was appointed Professor of Chemistry at Dacca College where he served till 1918. Since then, he held the Professorships at Government College, Lahore and Patna College. He was appointed Senior Professor of Chemistry, Ravenshaw College, Cuttack, in 1921, which post he has been holding ever since. He was President of the Indian Chemical Society, 1931-33 and President of the Chemistry Section, Indian Science Congress, 1920. Dr. Singh has built a school of research in Chemistry at Cuttack and is well known for his keen interest in educational affairs.

* * *

*J. N. Das Memorial Medal.*—Applications are invited for the award of a Gold Medal of the value of Rs. 70 (Rs. 100 for 1934) in memory of late Mr. J. M. Das Gupta. The medal will be awarded every alternate year to the best candidate for investigation on a subject relating to any branch of chemistry on the following conditions:

(1) Only unpublished researches or those published in the *Journal of the Indian Chemical Society* during the period shall be taken into consideration.

(2) The Society shall have the right to publish in its *Journal*. the whole, a part, or a modified form of thesis for which the medal is awarded.

(3) The medal shall not be awarded more than once to the same candidate.

(4) No paper on the presentation of which any other prize or degree other than M.A. or M.Sc. has been obtained, will be accepted. Further information can be obtained from the Hony. Secretary, Indian Chemical Society, 92, Upper Circular Road, Calcutta.

* * *

We acknowledge with thanks the receipt of the following :—

"The Journal of Agricultural Research," Vol. 49, Nos. 4 and 5.

"Indian Journal of Agricultural Science," Vol. 4, Pts. 4 and 5.

"Contributions from Boyce Thomson Institute," Vol. 6, No. 3.

"The Journal of the Indian Botanical Society," Vol. 13, No. 3.

"The Journal of the Institute of Brewing," Vol. 40, Nos. 10 and 11.

"Canadian Journal of Research," Vol. 2, No. 4.

"The Chemical Age," Vol. 31, Nos. 799 to 803.

"Berichte der Deutschen Chemischen Gesells chaft," Vol. 67, No. 11.

"The Cambridge Bulletin," No. 75, Nov. 1934.

"The Experimental Station Record," Vol. 71, Nos. 3 and 4.

"Educational India," Vol. 1, No. 5.

"Indian Forester," Vol. 60, No. 12.

"Forschungen und Fortschritte," Jahrgang 10, Nos. 30 and 32.

"The Journal of the Geological, Mining and Metallurgical Society of India," Vol. 6, No. 3.

"The Indian Trade Review," Vol. 12, No. 70.

"Research Publications of the Punjab Irrigation Research Institute".—

Vol. 1, No. 4. April 1933. An Investigation of the rise of water table in the Chenab Canal area, Punjab.

Vol. 2, No. 6, February 1934. An Investigation of the flow of water in Khanki Weir and the pressures on the floor.

Vol. 3. No. 1. An Analysis of the Utilization of Irrigation Water in Typical Punjab Canals.

Vol. 4, No. 1, February 1934. A gravimetrical survey of the Sub-Alluvium of the Jhelum-Chenab-Ravi-Doabs and its application to problems of waterlogging.

Vol. 4, No. 6, A simple method for determining the reaction and titration curves of soils.

Vol. 5. No. 2, January 1934. The Transmission coefficients of water in natural silts.

"Monthly Statistics of the Production of certain selected Industries of India," August 1934 (Government of India Publication).

"Communications from the Kamerlingh Onnes Laboratory of the University of Leiden," 224-228; Vol. 20, Supplements Nos. 70-75. November 1931 to September 1933, Nos. 217-228.

"The Association of Special Libraries and Information Bureaux; Report of the Proceedings of the 11th Conference."

"Advance Proceedings of the Asiatic Society of Bengal," Vol. 1, No. 2, November 1934.

"Report of the Forest Research Board for the year ending 31st March 1934 with Report of the Director of Forest Research," published by His Majesty's Stationery Office, 1934.

"Mathematics Student," Vol. 1, 1933.

"Memoirs of the Indian Meteorological Department," Vol. 26, Pt. 4, Discussion of Results of Sounding Balloon Ascents at Poona and Hyderabad during the period October 1928 to December 1931.

"Scripta Mathematica," No. 4, August 1934.

"Nature," Vol. 134, Nos 3390—3394.

"Natural History," November 1934.

"The Journal of Nutrition," Vol. 8, No. 4.

"The Journal of Chemical Physics," Vol. 2, No. 11.

"Journal de Chimie Physique," Tome 31, No. 8.

"Indian Journal of Physics," Vol. 9, Pt. 1, Proceedings of the Indian Association for the Cultivation of Science," Vol. 18, Pt. I.

"The R.I.S. Magazine," Vol. 1, No. 3, September 1934.

"Records of the Indian Museum," Vol. 36, Pt. 3.

"The Review of Scientific Instruments," Vol. 5, No. 10.

"The Indian Trade Journal," Vol. 115, Nos. 1481-1485.

## Reviews.

ACTUALITÉS SCIENTIFIQUES ET INDUSTRIELLES. No. 123. Les Surfaces Algebriques non Rationelles de Genres Arithmetique et Geometrique Nuls. By Lucien Godeaux. Pp 33. Price 10 Frs.

The conditions given by Enriques and Castelnuovo for a given algebraic surface of order $n$ to be rational are (1) The surfaces of order $(n-3)$ passing $(i-1)$ times through every multiple curve of order $i$ on the surface and $(j-2)$ times through every multiple point of order $j$ should pass through all the adjoint curves of the sections of the surface on every plane of space; and (2) Surfaces of order $(2n-8)$ passing $(2i-2)$ times through every multiple curve of order $i$, and $(2j-4)$ times through every multiple point of order $i$ do not exist. Now the condition (2) obviously includes the following condition, *viz.*, (3) The surfaces of order $(n-4)$ passing $(i-1)$ times through every multiple curve of order $i$ and $(j-2)$ times through every multiple point of order $j$ do not exist.

This monograph deals with the general construction and properties of surfaces for which the conditions (1) and (3) are satisfied and (2) is not satisfied; or in other words surfaces whose arithmetical and geometrical deficiencies are zero. The first example of such a surface given by the authors mentioned earlier is the quartic surface having the sides of a tetrahedron as double lines. The first few pages of the book are devoted to a sketch of the elementary theory of algebraic surfaces and the reader is referred to the standard works of Severi and Picard-Simart for details and further development. Next the determination of the deficiencies of higher orders of the various special surfaces in view is treated. It is shewn that the bigenre or the deficiency of the second order of the previously-mentioned surfaces is one. It is interesting to note that Enriques has proved that all surfaces whose arithmetical and geometrical deficiencies are zero and whose bigenre is unity is birationally equivalent to this surface. Next we find the proofs of the existence and some properties of Castelnuovo's surface, *viz.*, a seventh degree surface having a triple line R and a double conic $r$ which does not intersect R and which has three tacnodes A, B, C, whose tacnodal planes pass through R. This surface also belongs to the species of surfaces in view. The monograph ends with

the general method of constructing such surfaces. One interesting example of such a surface given by the author is a seventh degree surface circumscribed to a tetrahedron having as tacnodal curves any four sides of the tetrahedron forming a skew quadrilateral. The book presupposes on the part of the reader a good knowledge of the theory of algebraic surfaces.

K. V. I.

* * *

ELEMENTARY QUANTUM MECHANICS. By R. W. Gurny. (Cambridge University Press, 1934; pp. 160). Price 8s. 6d. net.

Books on Quantum Mechanics can well be divided into three classes. Books like those of Dirac, Weyl and Neumann appeal to the mathematician and mathematical physicist, while those of Darwin and Lindemann serve the layman. A third class typified by Frenkel's first volume and Mott's outlines is intended for the consumption of the experimentalist. The book before us definitely belongs to the last category and among books of this nature, it breaks new ground in its method of presentation. It is best described by altering its title to "Anschaulich Quantum Mechanics" if such a medley of words were permissible. The author very ingeniously carried out the programme of "fitting" $\psi$-patterns into potential boxes by means of a large number of carefully thought out diagrams. The advantages of this graphical method have really been two-fold. It has not only been possible to explain the fundamental principles clearly, but space has been found to deal with a large number of important applications in a semi-quantitative manner. As examples might be cited the sections on diatomic molecules, valence bonds, electrons in crystals, insulators and conductors, excitation and dissociation. More than to the experimentalist, this book will be found to be of value to the mathematician and will prove to him a sort of an oasis in the middle of the arid desert of quantum symbolism.

There is a short mathematical appendix at the end, but it is doubtful if it will serve any useful purpose; for no physicist, even an experimentalist, who does not know the mathematics contained in the appendix, is likely to be benefited by the book. The author has, in our opinion, very wisely refrained from giving an account of the Dirac theory of the electron.

Nothing need be said as regards the printing since it has been done at the Cambridge University Press. The price too is very reasonable.

B. S. M.

* * *

THE DIFFRACTION OF X-RAYS AND ELECTRONS BY AMORPHOUS SOLIDS, LIQUIDS AND GASES. By J. J. Randall. (Chapman and Hall, xii + 290, 1934.) Price 21s.

The book under review is a welcome addition to the literature on the subject and a mere perusal of it will show that it will be one of the best works on that subject.

Beginning with a brief survey and touching on the essential elementary principles of X-Ray crystallography, the author proceeds to deal with the Diffraction of X-Rays and Electrons by Gases and Vapours. Appropriately enough Chapter V has been dealt with in detail. Starting with the historical aspect of the problem of Diffraction of X-Rays (and Electrons) by Liquids he gives the different theories advanced by workers like Raman, Stewart, Prins and Debye. Next he discusses the experimental results obtained with both organic and inorganic liquids in the light of the above theories. The remaining chapters of the book are devoted to subjects like :—Some Important Examples of Amorphous and Microcrystalline Solids; The Structure of Organic Fibres; X-Rays, Electrons and Surface Structure; The Transition from Solid to Liquid; Isotropic Melts. Finally at the end, the author has given tables of Atomic Scattering Factors for X-Rays, Tables of Atomic and Ionic Radii and Tables of $\frac{\operatorname{Sin} x}{x}$ the value of which is evident to those working on this and allied subjects.

Speaking about the development of the subjects dealt with by the author one is struck by the clear and logical treatment aided by the accompanying set of beautiful photographs which is a characteristic feature of this book. The book supplies a long-felt need by workers on X-rays and electron diffraction since other treatises on X-rays and crystal structure make but a passing reference to such problems as the examination of amorphous solids, liquids, gases and surfaces by X-rays and electron diffraction methods. A comprehensive bibliography is given at the end of each chapter which will be found of great use. We have no hesitation whatever in

recommending the book to advanced students of Physics and workers on X-Rays and Electron Diffraction.

* * *

BIOCHEMICAL AND ALLIED RESEARCH IN INDIA IN 1933. Society of Biological Chemists (India), Indian Institute of Science, Bangalore.

The volume under reference is the fourth annual publication issued by the Society and covers most of the work published during 1933. The present one differs from its predecessor in that a chapter on Agricultural Industries is included, while General Microbiology is omitted. The total number of 238 references which are abstracted in this pamphlet is sufficient testimony to the volume of work conducted in the different scientific departments and in the various research institutions and colleges. Problems relating to agriculture and animal nutrition have naturally engaged the attention of investigators and many of them still await solution.

It will be quite useful if the Committee of Publication preface the publication with a short critical review of the most outstanding contributions that have been made during the year. There is no doubt that the value of the booklet will be greatly enhanced.

The get-up of the book is neat and the Society has to be congratulated on its efforts. It is probably an omission that the price of the pamphlet is not stated.

V. I.

# Forthcoming Events.

## Indian Science Congress, 1935.

The Twenty-Second Annual Meeting will be held in Calcutta from January 2nd to 8th, 1935. Dr. J. H. Hutton, M.A., D.Sc., C.I.E., I.C.S., F.A.S.B., Deputy Commissioner, Naga Hills, Kohima, Assam, will preside.

## Society of Biological Chemists, India.

January 5th, 1935, 3 p.m. Annual General Body Meeting at Calcutta.

## Lucknow University, Faculty of Science.

## Special Lectures, Session 1934-35.

The following short courses of Special Lectures have been organised at the invitation of the Inter-University Board and in pursuance of recent resolutions passed by the Faculty of Science and the Academic Council of Lucknow University. While the main object is to promote advanced study and research, it has been arranged that at least in some cases the introductory lecture in each course should present the more general and popular aspects of the subject, as far as possible in a non-technical manner. It is thus hoped to stimulate the interest of the educated public and of scientists working in related fields.

Jan. 12, 13, 14, at 6-30 p.m. Biology Theatre.
"Respiration in Plants." By Mr. H. P. Chowdhury, Lecturer in Botany.

Jan. 19, 20, 21, at 6-30 p.m. Chemistry Theatre.
"Liesegang Rings and the Influence of Media on their Formation." By Dr. A. C. Chatterji, Lecturer in Chemistry.

Jan. 26, 27, 28, at 6-30 p.m. Physics Theatre.
"Magnetism in relation to Chemical Problems." By Dr. K. N. Mathur, Lecturer in Physics.

Jan. 29, 30, 31, at 6-30 p.m. Chemistry Theatre.
"Photochemical Processes." By Mr. P. S. MacMahon, Professor of Chemistry.

Feb. 2, 3, 4, at 6-30 p.m. Biology Theatre.
"Saltation and Related Phenomena in Fungi." By Dr. S. N. Das Gupta, Reader in Botany.

# Errata.

Vol. II, No. 12, pp. 464-66, "Studies on the Pollen Tubes."

In Table 3, *read* 4·7, 5·2, 5·7, 6·2, 6·7, 7·2, 7·7, 8·2, 8·7, 9·2, 9·7
*for* 47, 52, 57, 62, 67, 72, 77, 82, 87, 92, 97.

Vol. III, No. 5, page 201, column 2, line from top, *read* 0·02 mg. *for* 0·2 mg.

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CONTENTS.





5

# Planned Economy.*

IN his recent vivacious volume, *Scientific Research and Social Needs*, Prof. Julian Huxley has shown us the close linkage between Science and Industry. The Industrial Revolution of the last century was the result of the application to industry of the scientific discoveries of the time, and since then there has been a continuous application of science to industry, on the mechanical as well as on the chemical side. There has been a remarkable spurt during the post-war period in the application of science to economic life, and we are now living through an Industrial Revolution of far greater magnitude and significance to humanity than the earlier one. It has been suggested that the problem of production has been at last solved, and it is now a question of apportioning work and leisure equitably among the members of a community. The problems of Production which were the main concern of the Industrial West in the 19th century are now replaced by problems of Distribution.

Before the community can attend to these problems, it is necessary to face another, *viz.*, the problem of adjusting the economic framework of society to the altered conditions. Science which has affected the methods of industry and its scale has also indirectly influenced social policy. In the early 19th century, when mankind wanted to reap the fruits of the scientific discoveries, economic progress depended on removing the obsolete and vexatious shackles of Mercantilism and excessive State interference, and therefore Industry only wanted the State to stand out of its sunshine. But side by side with increased production and trade, the evils of unregulated Industrialism were making themselves felt, and interference of the State with Industry to ameliorate the lot of the workers became imperative. For nearly a century State intervention was confined to the field of Distribution, without, however, affecting the structure of industry. The problem of wages and the relief of the unemployed were the chief questions that occupied the attention of economists and statesmen, but it is now realised, as has been pointed out by the Director of the International Labour Office, that "the problem of wages has been

* *Planned Economy for India.* By Sir M. Visvesvaraya, K.C.I.E., LL.D., D.Sc., M.I.M.E. Bangalore Press, Bangalore City, Mysore State, British India. Price Rs. 6.

merged in the wider problem of the adaptation of Production to Consumption .... The regulation of labour conditions is no longer so much a matter of protecting the worker against abuse as a part of rational organisation of society." The problem of the hour is to resolve the paradox of Poverty in the midst of Plenty. For, the present economic depression and the widespread unemployment in the World are all due to the fact that we have failed to adopt the organisation of industry to the new phase of mechanical progress which mankind has entered upon without fully realising its social and economic implications. The belief in the powers of self-adjustment of the economic machine has been smothered in the unlifting gloom of the last four years, and there is a growing feeling that the economic life of society must be subjected to conscious collective control. This is the meaning of the demand for Planned Economy.

The question arises whether such conscious collective control should be within the limits set by the present political frontiers, and the State in each country should plan for each as a separate unit, or whether there should not be some approach towards a World Plan. It is a platitude to say that the World has become one, and it has been argued that if the neotechnic economy of the present day is to survive, Industry must be organised on a World scale, and that for two reasons: The first is that the immense advance in the last few years in the means of communication has made physical barriers insignificant and political barriers irrelevant. In the second place, the geographical distribution of the rare earths and metals, which are of supreme significance for the new industrial order, based as it is on Electricity, is such that no country can be independent or self-sufficient. "The basis of the material elements in the new industry is neither national nor continental but planetary, and this is equally true of its technological and scientific heritage."* These facts making for what may be called a long period change happen, however, to be held in check at the present moment by widespread Economic Nationalism with National self-sufficiency for its objective, which is sought to be promoted by hindrances to various kinds of International Trade.

Whether the Economic Organisation of the World is to be unitary, in the sense of a World Plan in which the interests of the parts are rigorously subordinated to those of humanity at large, or a federal one which takes the interests of the parts as the starting point and seeks to reconcile them in a common synthesis, both World Planning and Economic Nationalism have to take account of two tendencies. The first is a continuous reduction of disparities between countries on the economic plane. With the development of automatic and semi-automatic machinery, it is certain that the range of industrial production will rapidly spread even in countries with no previous industrial experience, and it is on this ground that Mr. J. M. Keynes has supported a large measure of National self-sufficiency. Secondly, the basis of modern industry is Power, and the source of power has shifted in the last few years, and it has been argued that "the availability of water-power for producing energy, finally, changes the potential distribution of modern industry throughout the planet, and reduces the peculiar industrial dominance that Europe and the United States held under the coal-and-iron regime. For Asia and South America are almost as well as endowed with water-power—over fifty million horse-power each—as the older industrial regimes, and Africa has three times as much as either Europe or North America. Even within Europe and the United States a shifting of the industrial centre of gravity is taking place: thus the leadership in hydro-electric power development has gone to Italy, France, Norway, Switzerland and Sweden in the order named, and a similar shift is taking place toward the two great social spinal mountain-systems of the United States. The coal measures are no longer the exclusive measures of industrial power."† The combined operation of these two tendencies will bring about a radical change of distribution of the weight of production in the New Order, whether it be cosmopolitan or national in outlook.

World Planning, any more than Economic Nationalism, will not bring peace but a sword, because the advanced countries will be reluctant to surrender their predominance and allow themselves to be converted into 'derelict areas', while the backward countries will be equally determined in their unwillingness to submit

* Mumford, *Technics and Civilisation*.

† Mumford, *op. cit.*

passively to a crystallisation of their present economic status. But the march of events cannot be stayed. "Great economic and social forces flow with ideal sweep over communities only half conscious of that which is befalling them. Wise statesmen are those who foresee what time is thus bringing and try to shape institutions, and to mould men's thought and purpose in accordance with the change that is silently surrounding them" (Morley). India, like other countries, is faced with this problem of reconstruction and adjustment, and it is her good fortune that a statesman of Sir M. Visvesvaraya's authority and learning has given her leaders the fruits of his study, "how best the interests of a backward country like India could be furthered under the complex conditions of present-day civilisation". His work, *Planned Economy for India*, is indeed a tract for the times, but by no means a piece of hurried composition. It represents a slowly-built-up philosophy of life, as well as the results of a life-long study and of strenuous endeavours to enlist the co-operation of his country-men in the task of economic regeneration of their country.

His thesis may be briefly summarised: Economic progress is the pivot round which all other activities revolve, and the spread of the doctrine that poverty is a thing to be tolerated, is a great danger to guard against. At present an overwhelming proportion of the population in India is living below the poverty line. It is necessary that India should be rescued from the double disability from which she is suffering, *viz.*, her chronic economic backwardness, and the acute distress of the present moment as the result of the World Depression. While Indian agriculture should certainly be improved by the adoption of modern methods of scientific agriculture, the centre of gravity of economic reconstruction lies in the sphere of Industrialisation. India needs that a larger proportion of her people should be occupied in industries, and her industrial life should avail itself of mechanisation and mass production methods. These vast changes can only be brought about by the combination of three things: Scientific study of economic conditions with proper organisation of statistics, and an economic survey; creation of institutions, whose purpose will be to study the economic life of the country; and the formulation and operation of a plan of development.

In a Review devoted to the advancement of Science like ours, it is necessary only to touch on what might be called the scientific framework of Sir M. Visvesvaraya's thesis and the manner in which it figures in his important work. There can be no difference with Sir M. Visvesvaraya in his contention that economic activities are the basic condition of higher activities and that poverty is a thing not to be tolerated. There were stages in human history when comfort and leisure were the portion of the few, and hard drudgery the lot of the many. The political centre of gravity has shifted to the masses, who will not tolerate this uneven division of good things in life, while modern science is a powerful ally of Democracy in its demand that poverty shall be abolished for all. If India is to maintain her teeming millions on anything like a decent level of existence, and what is more, if the country is not to become a matter of concern and a menace to the rest of the World, it is necessary that the latest applications of science to agriculture, industry and transport, should be fully utilised so that the volume of production as well as the level of comfort may be raised.

Science is extending its frontiers, and fields of knowledge lying on the margin, or beyond the margin, of scientific study are being brought under cultivation. The life of society itself needs to be brought under the influence of Science, and it is here that the students of Science are under a special obligation to Sir M. Visvesvaraya in his warm belief and vigorous insistence that the facts* and the operations of Indian economic life can and should be subjected to measurement and scientific analysis. Right through his work there is a refreshing appreciation of the value of statistics, and his powerful plea for their proper organisation will surely receive the consideration that is its due. Measurement of social phenomena is yet in its infancy, and in no field of social activities are, perhaps, the need for measurement, and the chances

* Facts are the food of science: if we are going to be scientific about human nature and human society, instead of just trusting to blind social and economic forces (and see what a mess that blind trust has led us into!) let us begin by insisting on a proper supply of facts as grist to the scientific mill.—*Scientific Research and Social Needs*, by Julian Huxley.

of success, greater than in Economics. Economists for a long time were content with qualitative analysis, but in recent years there has been both a recognition of the need for, as well as a growth of, quantitative measurement. Sir M. Visvesvaraya's work is a gratifying indication to the World of Science that we in India are aware of recent developments in this important field of study.

N. S. S. R.

## Some Recent Advances in Indian Geology.*

By W. D. West,
*Geological Survey of India.*

### 3. The Geology of the Himalaya. †

THE SIMLA-CHAKRATA HILLS.

We may now consider the second area within the Himalaya which has of late received attention from the Geological Survey of India. In 1925 G. E. Pilgrim and W. D. West began a resurvey of the country between Simla and Chakrata, and were later joined by J. B. Auden. This area had first received attention from H. B. Medlicott so long ago as 1860, and was subsequently the subject of several papers by R. D. Oldham and others. It was Medlicott, however, who laid the foundations of our knowledge of this part of the Himalaya.

A feature of the geology of much of this country, which puzzled Medlicott and subsequent observers, is the occurrence of highly metamorphosed rocks, such as garnetiferous mica-schists and amphibolites, resting on top of practically unaltered rocks, such as the Simla slates. According to Pilgrim and West, these rock groups are not now in their original position relative to one another.[21] Detailed mapping and metamorphic considerations have led them to conclude that the metamorphic rocks, which are really part of the belt of rocks forming the central axis of the Himalaya, have been forced southward for many miles along a nearly horizontal thrust plane, so as to lie now on top of the unaltered rocks. These metamorphic rocks, named the Jutogh series, are seen forming the upper part of the ridge on which Simla is built, the small hill station of Chail, and the greater part of the Chaur mountain south-east of Simla. At the two former localities they occur as true 'klippe', since the effects of denudation have left them as isolated outliers capping the two hills. But the outcrop that forms the greater part of the Chaur mountain continues northwards along a high ridge, and so joins up directly with the main mass of crystalline schists and granites north of the Sutlej river. The Chaur outcrop is thus a direct southward extension of the rocks of the central axis of the Himalaya, and the way in which these metamorphosed rocks extend so far south as a nearly horizontal sheet, overlying the less metamorphosed slate-limestone group of rocks, is one of the most striking features of the geology. In addition to the major thrust plane along which the Jutogh series have travelled, there are other thrust planes in the rocks below, of which the Chail thrust is the most important. The crush phenomena found along the line of this thrust afford evidence of considerable horizontal movement here also. It is possible that the oncoming of the uppermost Jutogh beds like a gigantic wave from the north, induced the formation of the underlying thrusts, the rocks being piled up one on top of the other as a result of great horizontal compression.

Intruded into the Jutogh series there occurs the porphyritic gneissose biotite-granite which forms the upper part of the Chaur peak. This is the same rock as Stoliczka's 'Central Gneiss', and is one of a long series of intrusions stretching from Garhwal to Nanga Parbat. According to Pilgrim and West, the foliation which is found locally in it was developed at the time of its intrusion. Around the granite there is a definite increase in the grade of metamorphism of the Jutogh series, producing very coarse garnet-staurolite-schists, whilst kyanite is sometimes found.

The underlying less metamorphosed rocks comprise a number of series which have been given local names. These include the Chail, Simla, Jaunsar, Krol, Shali, Deoban and Tal series, together with the thin but important Blaini beds, which are now thought to be homotaxial with the Talchir

* Published with the permission of the Director, Geological Survey of India.

† Continued from previous issue, *Curr. Sci.*, 1934, **3**, 231.

[21] *Mem. Geol. Surv. Ind.*, 1928, **53**.

beds of Peninsular India, as first suggested by Oldham. The age of the rest of the rocks is at present quite unknown, though certain deductions may be made. These less metamorphosed rocks have been studied and mapped in detail by Auden along a narrow belt of country lying immediately south-west of the country mapped by Pilgrim and West, extending in an E.-S.-E. direction from Solon on the Kalka-Simla railway to the southern part of the Chakrata district.[22] It seems clear from his work that the rocks of this Krol belt are a thrust mass of Jaunsar-Blaini-Krol-Tal rocks, resting on a floor of Simla slates and Tertiary rocks, from which they are separated by the Krol thrust, which is itself folded. The details of the structures are too complicated to allow of easy summary, but, broadly speaking, there are two thrust-bound synclines overturned towards the south, the northern syncline being brought on by the Giri thrust, and the southern by the Krol thrust. The latter is the more important of the two, separating the Tertiary rocks from the pre-Tertiary. Oldham's 'Main Boundary Fault' comes still further to the south-west. East of Nahan the two latter thrusts meet, the Krol thrust appearing to overlap the other. Towards the south-east end of the belt the northern syncline opens out and includes a mass of Tal rocks, which overlie the Krol rocks unconformably. It will be remembered that comminuted fossils have been found in the Tal rocks of the type locality in Garhwal, but too damaged to be identified. In the southern portion of the Chakrata district, by and east of the Tons river, this belt of rocks is bounded on the north side by another thrust, the Tons thrust. As this thrust dips to the south and south-west, and as the Krol thrust on the south side of the belt dips northwards, it is suggested that the two thrusts are the same and join below, and that the great syncline of Jaunsar rocks, with overlying Krols and Tals, rests as a nappe on a folded thrust plane. The component beds of the two synclines are much folded, but this folding is not regarded by Auden as of structural significance, but as due to the incompetent nature of the beds. The two synclines have behaved as units, which have moved *en bloc*.

A point stressed by Auden is that too much emphasis has in the past been laid on a single 'Main Boundary Fault' as having borne the burden of the advance of the Himalaya, and in particular he rejects Lake's simple explanation of mountain arcs, which has already been referred to. As Middlemiss showed long ago, in addition to Oldham's 'Main Boundary Fault' there are several comparable faults within and bounding the Siwaliks on the one hand, and within and bounding the pre-Tertiary rocks on the other hand. And the more recent work on these latter rocks has only served to extend these observations, and to emphasise the importance of these other thrusts.

As regards the time of intrusion of the gneissose granite which is found in the Jutogh series, and similar granites elsewhere, *e.g.*, Lansdowne, Dudatoli, and the main mass of the Dhaoladhar range to beyond Dalhousie, which seems to be identical with what Stoliczka called the 'Central Gneiss', Pilgrim and West, while refraining from expressing any definite opinion except that it was probably pre-Chail in age and possibly Archæan, rejected McMahon's view that the intrusion took place during the Tertiary at the time of the upheaval of the Himalaya. Auden has now gone further, and has put forward reasons for supposing the intrusion to have taken place towards the end of the Palæozoic, suggesting that it occurred in connection with certain crust movements which he thinks took place in pre-Infra-Krol times, along a line coincident with the line of the old Aravalli mountains if continued north-eastwards from Delhi towards the Himalaya. This recognition of an older structure subordinate to the main Kainozoic structure of the Himalaya in these hills may prove to be important, though it would be surprising not to find evidence of some such break, considering the importance of the break between the Dravidian and the Aryan in so many parts of India. The suggestion that it is an Aravalli structure (based on the direction of minor folds in pre-Infra-Krol rocks, and the direction of orientation of phenocrysts in the Lansdowne granite) must await the results of further observation. Nevertheless it has received considerable support from the gravity investigations of the Survey of India, which suggest that there is an upward buckling of the floor of the Gangetic trough along a line stretching

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[22] *Rec. Geol. Surv. Ind.*, 1934, **67**, 357.

from Delhi towards Saharanpur.[23] In an earlier paper Auden discussed the age of certain Himalayan granites, and arrived at tentative conclusions based partly on such tectonic considerations.[24] According to him it seems definite that some of the granites of the Central Himalaya and border ranges closer to the Peninsula were intruded in pre-Triassic times, and belong to pre-Himalayan tectonics, though they are probably of more than one age. Considering very generally this question of the age of Himalayan granites, it appears from recent researches that the youngest type is a tourmaline-granite, the intrusion of which must have taken place in very late Kainozoic times. Another which is common in many parts of the Himalaya is a hornblende-granite with sphene and sometimes epidote. Around Nanga Parbat and in Ladakh it has metamorphosed the Panjal trap, while a similar granite is post-Cretaceous in age in the Everest region.[25] Of probably older age is the porphyritic gneissose biotite-granite, Stoliczka's 'Central Gneiss', so frequently referred to above. It is definitely post-Dogra slate in age, and, according to Wadia, is post-Carboniferous in the Pir Panjal.[26] Finally, pebbles of older granites have been found in the Panjal Agglomerate, in the breccia at the base of Middlemiss's Purple Slate series, and elsewhere. It is thus clear that there are a number of granites in the Himalaya of different ages; but their relative importance, and the part that any of them may have played in the Kainozoic mountain building movements, or in the metamorphism of Palæozoic sediments to crystalline schists, cannot at present be determined with certainty, and will have to await the detailed mapping of one complete section of the Himalaya.

In discussing the metamorphism of the rocks of the Krol belt, which is of a low *epi* type, Auden suggests that the greater metamorphism displayed by the rocks in the Chaur area further north-east is due entirely to the intrusion of the Chaur granite, and rather infers that had there been no granite then the rocks would have displayed no greater metamorphism than the rocks of the Krol belt.[27] His views are based on a general consideration of the metamorphism displayed by the rocks in the Simla area, and in particular on a visit to Lansdowne and an inability while there to find any discordance separating the garnetiferous schists surrounding the Lansdowne granite from the less metamorphosed rocks further away. This is contrary to the opinion expressed by Pilgrim and West, who regarded the Jutogh series as an older set of rocks which everywhere display a *meso*-grade of metamorphism, locally intensified by the Chaur granite. They were impressed with the importance of the Jutogh thrust, which has brought the Jutogh rocks, together with the Chaur granite and its associated igneous rocks, into contact with rocks displaying only an *epi*-grade of metamorphism, or no metamorphism at all. They fully realised, however, the possibility of the Jutogh and Chail series both being older than the metamorphism, which might have metamorphosed them to different grades before the thrusting brought them into juxtaposition. The matter is referred to at some length here because it is a problem of prime importance. Leaving out of consideration the evidence for the Jutogh thrust, it is really a problem of explaining how, on the assumption that there has been no thrusting, the uppermost rocks with a roughly horizontal disposition have come to be intruded with granites, while the underlying rocks have escaped the intrusion. The presence of the Jutogh thrust between the two sets of rocks explains the anomaly, but it is a solution which may have only a local application, and of course throws no light on the relative ages of the rocks. In an unpublished report on traverses in Eastern Nepal, Auden has developed his point of view a step further by definitely suggesting that the Daling series pass up by increasing metamorphism into Darjeeling gneiss, the latter consisting mostly of para-gneiss and schist. Here again the more metamorphosed rocks, with their accompanying ortho-gneiss and granite, overlie the less metamorphosed Dalings. According to Auden the two are the same, the Dalings belonging to the *chlorite* zone of metamorphism and the Darjeeling gneiss to the combined *biotite-garnet* zones. This question of the age or ages of the crystalline schists in the Hima-

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[23] *Geodetic Report*, 1933, **8**, 57.

[24] *Rec. Geol. Surv. Ind.*, 1933, **66**, 461.

[25] *Op. cit.*, 1932, **66**, 224; and *Mem. Geol. Surv. Ind.*, 1907, **36**, 183-184.

[26] *Mem. Geol. Surv. Ind.*, 1928, **51**, 223.

[27] *Rec. Geol. Surv. Ind.*, 1934, **67**, 406-419.

laya is full of difficulties and will possibly only be solved in an area where there is no extensive thrusting. The problem is an important one, and with it is bound up the question of the age of some of the granites.

Some 40 miles north-west from Simla, in Mandi State, S. K. Roy has noted folded dolomitic limestones, which he suggests may be Krol in age, resting partly on Kainozoic rocks and partly on slate and volcanic rocks of pre-Kainozoic age.[28] He suggests that these limestones are 'klippe' of older rock resting on younger rocks, their roots being found in Kulu some 16 to 20 miles further east.

As regards the age of the thrusting, Auden has pointed out that the Krol thrust near Kalsi brings the pre-Tertiary rocks to rest upon Nahans. The thrust must therefore be of Upper Miocene or later age. As bearing upon this same question, interesting evidence has very recently been brought forward (but not yet published) by H. M. Lahiri, working between Nalagarh and Anandpur, that is along the edge of the foothills nearly due west of Simla. Over a distance of about one and a half miles Lahiri has found Dagshai beds (Miocene) resting horizontally or with a slight south-westerly dip on the top of boulder conglomerates belonging to the Older Alluvium (Pleistocene). It seems clear that the Dagshai beds must have been thrust over the younger boulder conglomerates, and the thrusting must have taken place in late Pleistocene or very recent times.

One of the most remarkable features about these Simla series—Krol series set of rocks is the complete absence of fossils in them, making it difficult to determine the age of the rocks. The Blaini beds with their supposed glacial boulder bed may reasonably be regarded as homotaxial with the Talchir boulder bed of Peninsular India, and therefore to be of Upper Carboniferous age, though the point is not beyond dispute. But beyond that little can be deduced. It may be asked, how is it that while the thick series of sedimentary rocks on the Tibetan side of the central axis are fossiliferous, and include rocks ranging in age from the Cambrian to the Eocene, the sedimentary rocks on the southern side of the axis are completely unfossiliferous, though they include rocks which must have been formed at the same time. The question is a difficult one to answer. It may be due partly to the fact that many of the limestones of the Simla area are dolomitised, during which process the fossils may have been destroyed. But there are many other rocks such as slates and shales, suitable for the preservation of fossils, which have undergone little or no alteration. Yet so far not even the trace of a fossil has been found in the pre-Tertiary rocks. It is possible that during the long period of time during which deposition was proceeding, the sea over the Simla area was separated from the northern sea or Tethys by high land over what is now the central axis of the Himalaya. And it may be that the physical conditions of this southern sea were unfavourable to the presence of abundant life. That this may have been so is evident from the shallow water nature of many of the rocks, from the evidence which they provide of having been formed under unhealthy conditions, and from the fact that desert conditions may have prevailed over the adjacent land areas, as suggested by Auden.[29] Between the Simla hills and Spiti there occurs the broad belt of the crystalline schists and gneisses forming the central axis of the Himalaya, so that continuous mapping of the limestone-slate series from one area to the other is impossible. Attention, however, may be drawn to the fact that further north-west, to the south-east of Chamba, judging from our scanty knowledge of the geology as represented on the 32 miles to the inch geological map, this dividing belt of crystalline schists is for a short distance very thin. It may be that we have in this locality the opportunity of correlating the unmetamorphosed sedimentary rocks of the two belts. Further north-west, towards Kashmir, there occurs a mingling of these northern and southern seas, and fossils begin to appear. But the exact age of the rocks in the Simla area will not certainly be known until fossils have been found in them, or until continuous mapping has been completed between Simla and Kashmir or between Simla and the Chamba to Spiti section.

COMPARISON BETWEEN SIMLA AND KASHMIR.

Comparing broadly the structure of this section of the Himalaya with the Kashmir area in the light of recent work, it seems

[28] *Quart. Journ. Geol. Min. Met. Soc. Ind.*, 1933, **5**, 131.

[29] *Rec. Geol. Surv. Ind.*, 1929, **62**, 168.

that the sedimentary rocks of the Krol belt correspond to Wadia's autochthonous zone in Kashmir; while the Jutogh and Chail series and the gneissose-granite correspond to Wadia's nappe zone. Auden's Krol thrust corresponds in position to Wadia's Murree thrust, and Pilgrim and West's Jutogh thrust (or possibly their Chail thrust) to Wadia's Panjal thrust. The chief difference between the two areas is that whereas in Kashmir several basins of fossiliferous sedimentary rocks are found resting in synclines on top of the Kashmir nappe, in the Simla hills–Spiti area nothing similar is seen until one reaches Spiti on the north side of the central axis. It is possible that such rocks once occurred further south than Spiti but have since been denuded away or have been so metamorphosed as to be now unrecognisable.

### EASTERN HIMALAYA.

Proceeding further south-east along the range, it has to be regretted that little advance has been made of recent years in our knowledge of the geology of this portion. So long ago as 1875 H. B. Medlicott published a note on the geology of Nepal, which was based on observations made during a journey along the main road to Khatmandu, and from there north-west up to Nayakot.[30] During this journey Medlicott found in a limestone on the crest of the Chandragiri pass 'some small facets of spar having a central puncture, and which I took to be crinoidal; but Dr. Waagen would not say positively that they were so'. Quite recently both Sutton Bowman and Auden have procured better specimens from the same locality, and there is now no doubt about their being fossils. They have been examined by Lahiri, who has identified them as cystids together with the brachiopod orthis. The interest of this discovery will be realised when it is remembered that this is the first discovery of cystids anywhere in the Himalayan area, these fossils having previously been found only in the Burma province. The rocks in which they occur must therefore be of Lower Palæozoic age, though it still remains to correlate them with rocks in adjacent tracts.

As already mentioned, Auden has made traverses recently in Eastern Nepal. As a result of this work he has been able to demonstrate with certainty the continuation westwards from Darjeeling of the Darjeeling gneiss and the Daling series. As no above, he regards the two as belonging to same series, but differently affected metamorphism. Amongst the Tertiary ro along the southern border of the hills found Middle and Upper Siwaliks dipp northwards beneath Nahan or Lower Siwa rocks. There must clearly be a thrust pl separating these two groups, while Tertiary rocks as a whole are separated fr the pre-Tertiary by another thrust, in manner similar to that found in the Sim Mussoorie area.

### THE MOUNT EVEREST AREA.

In 1921 Dr. A. M. Heron accompanied Mount Everest Reconnaissance Expediti and examined an area of over 8,000 squ miles around the Arun river and its tribu ries, to the north and east of Everest.[31] T is a continuation westwards of the coun surveyed by Hayden in 1903-4. The a examined by Heron is divided by him i a northern or Tibetan zone, comprising thick series of highly folded Jurassic roc containing narrow synclines of Cretace and Eocene; and a southern or Himalay zone, in which Everest lies, consisting foliated biotite-gneisses full of dykes a sills of tourmaline-granite and pegmat Between these two zones there lies an in mediate zone of metamorphosed sediment rocks, regarded by Heron as metamorpho rocks of the Tibetan zone. These rocks h a northward dip, so that the gneisses p upwards into the metamorphic rocks, a the latter upwards into the Jurassic roc The metamorphosed sedimentary rocks clude crystalline limestones, and actinol and epidote-schists. Ascending northward the succession the metamorphism decrea and fossil Spirifer and Productus were fou by Heron in the limestone. These rocks turn pass up into the unmetamorpho Jurassic rocks. The metamorphic rocks therefore regarded by Heron as Permian Triassic in age. According to L. R. Wag who accompanied the last Mount Eve expedition in 1933, these metamorphic ro include an upper series of quartzites a shales containing a brachiopod fauna probable Lower Permian age, underlain a limestone about 2,000 feet thick, wh forms the summit of Mount Everest, a which is probably either Permo-Carbo ferous or Carboniferous in age.[32] This

[30] *Op. cit.*, 1875, **8**, 93.

[31] *Op. cit.*, 1923, **54**, 215.

[32] *Nature*, 1933, **132**, 976.

turn is underlain by a pelitic series much injected by granite. As regards the Darjeeling district, Wager suggests that the Daling series are the equivalent of the Everest pelitic series, while he agrees with the large-scale inversion suggested by Mallet.

Before concluding this section reference must be made to a new edition of Burrard and Hayden's *A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*, first published in 1908. In the new edition, published this year, the part dealing with the geology has been brought up-to-date by Dr. A. M. Heron, and it should be in the hands of every geologist interested in Indian geology.

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# Cerebro-Spinal Meningitis.

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## History.

In 1805, an epidemic of cerebro-spinal meningitis occurred in Geneva and Vieusseux was the first man to describe the disease. In 1806 and 1807, the disease was prevalent in the Prussian army. From 1805 to 1830 it occurred in the United States of America and gradually spread from east to west. France was next attacked in 1837 and the disease spent its force in 1874. From 1854 to 1874, the disease occurred both in Europe and in America. From 1875 till now, the disease has spread throughout Europe and America and many places of Asia.

The present Indian epidemic started in the beginning of 1932 in Calcutta, when nearly 40 cases were admitted to the Calcutta Medical College within a month. Subsequently all the cases were admitted to the Campbell Medical School. The disease continued in its sporadic form and has now spread throughout Northern India.

## Epidemiology.

*Age.*—Children are more susceptible to the disease than adults. In the Danzig epidemic, 93 per cent. were under 5 years of age. In Calcutta, however, the disease is particularly prevalent amongst adults. Majority of the cases among children were of chronic character.

*Sex.*—In Calcutta, more males were attacked than females. As fatigue, chill and overcrowding are predisposing factors, the adults are more liable to infection than others. The purdah system is responsible for keeping the women indoors. The incidence is therefore less among the women. In certain cases, however, where women were exposed to overcrowding, the disease attacked them as well.

*Example.*—A female came from a moffussil to Calcutta for the anti-rabic treatment of her son. She had to attend the crowded out-door of the Pasteur Institute in the School of Tropical Medicine and Hygiene, and ten days after, she contracted cerebro-spinal meningitis and died within three days of the attack.

The congregation of individuals in meetings, cinema houses, markets, big railway stations, third class compartments, and such like are favourable to the formation of multiple foci and spread of the disease. In well-equipped jails, barracks and schools of Calcutta, however, no cases have been reported. One case was reported from Dumdum jail amongst detenues. According to Major Malaya not a single case has been reported from the Calcutta police lines with a population of six thousand.

The lowered vitality of the population owing to depressed economical condition must be one of the factors. Bad sanitary conditions of the Northern part of Calcutta was responsible for the larger incidence of the disease in that part of the city. The disease is not, however, highly contagious and is not spread by clothing.

*Season.*—In the case of the European epidemics, the incidence is usually very high in winter whereas in Calcutta, in 1932, the highest incidence was recorded in the months of April and May. 20 per cent. of the cases gave history of exposure to mid-day sun.

*Mode of the spread of the disease.*—Weigert found presence of purulent rhinitis in many cases of cerebro-spinal meningitis. The meningococci are also found in the nose of many healthy persons, who are the carriers of the disease. The habit of many people to blow out the secretions of their nose indiscriminately in rooms and streets is responsible for the dissemination of

meningococci. During and preceding epidemics, the career rate rises from 2 to 4 per cent. normal to 20 to 30 per cent.

*Route of Infection.*—The route of infection is through the nasopharynx. The organism sets up rhinopharyngitis, then the meningococci infect the meninges directly from the nose. This is the view held by Nelter and Detere (1911). The other view is that it is a hæmatogenic infection. The meningococci pass into the blood stream and are thereby carried to the meninges. This view is supported by the fact that in 25 per cent. of the cases, blood culture is positive. Esler, for example, reported that he recovered meningococci from the blood of 10 cases out of 41. Moreover, the organisms can be cultured from petechial spots just as *B. typhosus* can be recovered from roseolar rashes of the enteric fever.

## BACTERIOLOGY.

It was in the year of 1887 that Weichselbaum of Vienna first discovered the organism which on account of its intracellular character was named *diplococci intracellularis meningitidis*. That the organism was the cause of the disease was proved by the fact that Weichselbaum was able to cause the death of rabbits by subdural injection of the organisms into the skull and he recovered the cocci from culture of cerebro-spinal fluid of experimentally infected rabbits. Intra-pleural and intrathecal injections of the organisms caused death of guinea-pigs in 1 to 3 days. In dogs, subdural injections caused leptomeningitis with acute encephalitis and death occurred within 12 days.

In 1905, Von Lingelsham produced the disease in monkeys. In 1907, Flexner made experiments with *Macacus rhesus* which died within 18 hours to 4 days preceded by general convulsions. In post-mortem examinations, leptomeningitis, encephalitis, abscesses, hæmorrhages into pia-mater were found.

*Serological Classification.*—The English workers recognise four types (I, II, III, IV) as serologically determined by Gordon. The Rockefeller Institute recognises two types as determined by Dopter, *viz.*, meningococci and parameningococci. Dopter further subdivided parameningococci in $\alpha$, $\beta$ and $\gamma$ varieties respectively. Nicolle, Debains and Jonan divided meningococci into types A, B, C and D. These types were differentiated according to the predominance of different antigenic contents, *viz.*, A, B, C and D. In type I, A predominates. Similarly, in types II, III and IV, B, C and D predominate. These antigenic contents are not equally balanced. This can be illustrated by the following scheme:—

Gordon's I and III strains correspond to Nicolle, Debain and Jonan's type A.

Gordon's II and IV strains correspond to Nicolle, Debain and Jonan's type B.

Dopter's meningococcus corresponds to Nicolle, Debain and Jonan's type A.

Dopter's parameningococcus $\alpha$ corresponds to Nicolle, Debain and Jonan's type B.

Dopter's parameningococcus $\beta$ corresponds to Nicolle, Debain and Jonan's type B or C.

Dopter's parameningococcus $\gamma$ corresponds to Nicolle, Debain and Jonan's type D.

*Causes of Sporadic Occurrences.*—Meningococci carriers are not uncommon. The germs inhabit the nasopharynx. They are usually non-virulent in non-epidemic times but certain strains of the cocci are sufficiently virulent to attack very young children who lack defensive forces and are susceptible. Hence we have cerebro-spinal fever occurring sporadically amongst us.

*Morbid Anatomy.*—The meninges are actually congested and fibro-purulent exudation collect between dura and pia mater. In acute cases, the whole cortex is covered with thick pus. The cord is also involved and covered with purulent exudate, which is distributed more in the dorsal and lumbar regions than the cervical regions.

Microscopically, the exudate is full of polymorphonuclear cells, containing meningococci. These leucocytes are closely packed in fibrinous material.

## DIAGNOSIS.

*Clinical Diagnosis.*—Besides Kernig's and Brudzinisky's signs, the disease can be clinically diagnosed mainly by the sudden onset of fever, pain, stiffness, rigidity and retraction of the muscles of the neck, pains in the back, orthotonus, tremor and headache. In severe cases, the patient becomes delirious and unconscious. In children, clonic spasms are frequent, and in a few adults, both clonic and tonic spasms are sometimes manifested. Herpes is common due to affection of the posterior ganglion. The pupils are usually contracted and sometimes unequal. Strabismus is not uncommon.

*Classification of the Disease.*—(1) In the beginning of the epidemic, *foudryant* or malignant forms are common. There is sudden rise of temperature which, however,

is not very high, but malaise, lassitude, stupor, low condition, feeble pulse and such other symptoms all indicate the seriousness of the disease. There is usually the appearance of rash, petechial, purpuric and sometimes this resembles the Malaccan smallpox. The patient quickly becomes unconscious and death occurs in 5 to 24 hours.

(2) The ordinary form has already been described.

(3) In the chronic form, the fever is persistent for two to six months and is characterised by a series of ups and downs. In favourable cases the temperature gradually comes down, spasms become less and less manifest and consciousness returns. Various complications may, however, arise in this condition. They are hydrocephalus, abcess of the brain, pneumonia, pleurisy, pericarditis, parotitis, polyarthritis, persistent headache and such like.

(4) Some cases occur as abortive forms, in which the onset is like that of acute cerebro-spinal fever, but the symptoms suddenly subside and the patient recovers quickly.

*Other Varieties of Cerebro-Spinal Meningitis.*—Besides meningococci which invade meninges in sporadic and epidemic forms, there are other organisms which may cause cerebro-spinal meningitis. They are pneumococci, streptococci, tubercle bacilli, influenza bacilli, bacilli typhosus including (para A and B), plague bacilli, virus of mumps and such others.

The *pneumococcal meningitis* is invariably fatal. A few cases have recently been reported to have recovered after exhibition of Felton's serum. It occurs more commonly in children than in adults.

The *streptococcal meningitis* is usually an extension of septic infection from middle ear disease and perforated wounds of the skull. The streptococci are usually of hæmolytic type. The disease is usually fatal.

The *tubercular form* is usually common in children and is practically always fatal.

The *influenza bacilli* can cause meningitis. The bacilli are found in long thread-like forms in cerebro-spinal fluid. They resemble Pfeiffer's bacilli but differ in exhibiting a high pathogenicity. Intra-peritonial injection of these bacilli into guinea-pigs and rabbits is followed by purulent effusion into serous cavities. According to Bender, influenzal meningitis is fatal in 91 per cent. in children and 44 per cent. in adults.

The meningitis which occur as complication of typhoid or paratyphoid fevers is fatal in 50 per cent. of the cases. The cerebro-spinal fluid is clear or turbid but seldom purulent like that of meningococcal meningitis.

*Laboratory Diagnosis.*—The blood examination shows polymorphonuclear leucocytosis with increased stabkernige and younger forms. Traces of albumin are present in the urine. The most important method of laboratory diagnosis is the examination of cerebro-spinal fluid got from lumbar or cisternal puncture. The fluid is centrifuged and the sediment is spread over a slide, stained by Gram's iodine and counterstained by carbolfuchsin. The meningococci are gram-negative diplococci usually found within the polymorphonuclear cells which are abundantly increased. In cerebro-spinal meningitis, the polynuclears predominate, in tubercular meningitis the lymphocytes are most abundant. The coccal organisms are gram-positive in streptococcal and pneumococcal meningitis. These gram-positive organisms can be easily differentiated by morphological appearances and their disposition. The cerebrospinal fluid of tubercular meningitis shows reduction of both sugar and chlorides. The normal amount of sugar in cerebro-spinal fluid is 45 to 95 mg. and of chlorides is 720 to 750 mg. per 100 c.c. In tubercular meningitis, the estimation of chlorides is very important for prognostic purposes, especially in children. Ordinarily the amount of chlorides is reduced to 650 or 680 mg. but in children 580 to 500 mg. may be reached. The globulin is increased even in early stages.

For determining whether globulin is increased or not, either Ross Jone's test or Pandy's test may be done. In Ross Jone's test a distinct white ring of globulin is formed at the junction of saturated solution of ammonium sulphate and cerebro-spinal fluid in a test tube. In Pandy's test, if a drop of cerebro-spinal fluid is put in a saturated solution of carbolic acid, a smoke-like white cloud is formed instead of faint opalescence as with normal cerebro-spinal fluid.

For final diagnosis of tubercular meningitis inoculation of guinea-pigs is confirmative.

*Vincent and Bellot's Precipitin Test.*—Half a c.c. of antimeningococcal serum is added to 5—10 c.c. of cerebro-spinal fluid and kept in an incubator at 37°F. for 12 hours. A turbidity is developed if the patient is suffering from cerebro-spinal meningitis.

*Culture.*—This is the surest way of diagnosis. One c.c. of cerebro-spinal fluid is spread over two or three plates of ascitic agar or Gordon's trypagar. Colonies are formed within two days. The cocci are suspended in normal saline. A small quantity of this emulsion suspension is treated with each type serum in water bath for 4 hours at 55°C. If agglutination occurs against a particular type serum, the meningococci belongs to that group.

*Agglutination Test of Blood Serum.*—The test is positive only in 50 per cent. of cases. The agglutinins are not formed in markedly toxæmic cases. According to Symmeris and Wilson, the serum of cerebro-spinal meningitis occasionally agglutinated *B. typhosus* and *B. coli* even in high dilutions.

*Naso-pharyngeal Culture.*—The organisms live in the posterior nasopharynx. The smear should be collected with West's swab, which is a bent wire applicator with a sterile cotton tip put within a bent glass tube, so that the cotton tip can be protruded or retracted at will. This tube is introduced into the nose and when it has passed the soft palate, the cotton swab is pushed out so as to get the material from the nasopharynx and is at once smeared on ascitic or serum agar. The smear from the nasopharyngeal region can also be examined on a glass slide but it has to be differentiated from micrococcus catarrhalis. The meningococci are usually found within the polymorphonuclear cells but they may be extracellular. They may be easily differentiated after culture.

*Autolysis.*—Occasionally, the cerebro-spinal fluid is full of pus cells but no meningococci can be detected in them nor is the culture positive. In these cases, the meningococci have undergone autolysis. The streptococci and pneumococci do not undergo any such autolysis. Hence if the cerebro-spinal fluid contains abundance of pus cells, yet no meningococci, the case is almost surely meningococcic meningitis.

*Prognosis and End Results.*—During irritative stages, the pupil remains contracted and deep jerks become exaggerated. The dilatation of the pupils and disappearance of the jerks indicate impending death. Oedema of the lungs is always of bad prognosis.

*Prophylaxis.*—The disease is notifiable. Cases should be isolated at once. The contacts should have gargles of thymol solution or salt solution. The nasopharynx can be reached by means of intranasal sprays of chloretone inhalent, mistol, hexyl resorcinol, or they can be applied by bent camel hair brush through the opening of the mouth. It has been found, however, that all these methods of local disinfection are valueless. Even prophylactic treatment with immune serum has not got any definite value.

During an epidemic, 20 to 30 per cent. of healthy persons carry meningococci in their nasopharynx. In congregation and overcrowding, the infection may spread from carriers to healthy people. It is necessary to stop meetings, cinema and theatrical shows unless the houses are air-conditioned and adequately ventilated. In barracks and jails, systematic examination of nasopharynx should be done and carriers isolated in a separate block. The spacings between cots should be increased and strict supervision of sanitary measures should be undertaken.

*Vaccination.*—Vaccination is quickly followed by production of antibodies in the system and is certainly effective so far as prophylaxis is concerned. The carriers do not usually get the disease. The medical practitioners, nurses and hospital attendants seldom get the disease. The English naval statistics indicate that the disease almost always develops in those who have previously shown negative cultures from nasopharyngeal smears. This is an additional factor to support that carriers develop antibodies in their system to some extent, but they may get the disease if they are exposed to resistance reducing factors, like exposure to chill, cold, excessive fatigue and such like. These carriers are vastly more common in winter than in summer.

## TREATMENT.

The patient should be kept quiet; all causes of irritation should be removed. Special attention is to be directed against bed sores. The hair should be clipped or shaved; icebag should be applied to the head. Water should be given freely.

As the patient usually suffers from constipation, 5 grains of calomel should be given in the evening followed by saline purge next morning. Later, daily enema of soap and water in which two tea spoonfuls of castor oil or an ounce of olive oil is mixed, should be given.

For severe headache, general pains and vomiting, morphia has been frequently used. It quietens the restlessness and irritability, relieves pain and vomiting and procures sleep. Dr. Koplik is, however, of

opinion that morphia is harmful. Every one is, however, agreed about the efficacy of lumbar puncture, which relieves headache by reducing the pressure on duramater. The elimination of toxins with cerebro-spinal fluid will cause subsidence of irritation of vomiting centre. If these symptoms are not relieved by lumbar puncture, chloral hydrate and bromide, ten grains each, should be tried before giving morphia.

*Hydropathy.*—Hot baths are very soothing, and, if possible, should be given every 3 hours. It will reduce the temperature and sometimes induces sleep.

*Serum Therapy.*—Jochmann first introduced this treatment. In 1907 and 1908, Flexner and Jobling prepared sera from goat, horse, rabbit and guinea-pig. Out of 1,291 patients treated with serum, 891 recovered and 400 died. The mortality was thus reduced from 74 to 30 per cent. The earlier the serum was given, the better was the result. The leucocytes which increased to about forty thousand, fell to normal within a week after serum treatment. Pus cells became fewer and the cerebro-spinal fluid became less turbid. Another striking feature was that the complications were lessened by serum therapy. The usual complications in those epidemics were iridocyclitis, panophthalmitis, deafness due to internal ear disease, pleurisy, pericarditis, endocarditis, arthropathies, insanity and others.

The mode of preparation of serum varied in different countries. There is no laboratory method by which therapeutic power may be correctly determined. Some rely on *compliment fixation* test, some on *opsonin* content, some on *protective* power. Gordon relies on *anti-endotoxic* power. Riviere and Roux proposed a *precipitin* test.

The failure of serum in many hands is due to preparation from different strains. In the year 1932, out of 43 patients admitted into the Medical College Hospitals, Calcutta, only three survived although everyone was treated with foreign brand serum. A great majority of these cases were foudryant or malignant forms; no impression was manifested by exhibition of those sera. It was understood that the failure was due to sera obtained from different strains of American and European meningococci. Failing to get any good result from foreign brand sera I sent some cultures and cerebro-spinal fluids of my patients to Dr. B. B. Sen of Bengal Immunity Co., requesting him to find out the type of meningococci and also to prepare the serum from the local strains isolated from my patients. He brought materials not only from me but also from the Campbell Hospital, Calcutta, where special accommodation for treating meningitis cases was subsequently created. Out of 25 samples collected by him, one contained streptococci and another pneumococci; from the rest eleven strains of meningococci were isolated. Nine were found to correspond to Gordon's type IV and two to type II. That is to say, at the beginning of the year 1932, the prevailing organism of the epidemic were of Gordon's II and IV types, which were the same as Nicol, Debaun and Jonan's $\beta$-type or Dopter's parameningococcus $\alpha$-type. Next year, research workers of the Bengal Chemical Works took up the investigation. Out of 150 samples of cerebro-spinal fluid, 120 showed meningococci. It was found that in none of the samples type II or IV were detected. All of them showed either Gordon's type I or type III which were the same as Dopter's typical meningococci and Nicol's, Debaun's and Jonan's type A. It is, therefore, evident that the types may vary in different epidemics in the same place in different years.

In the latter part of the year 1932, several more cases were treated by me. In all of them locally manufactured sera were used. The result was very satisfactory, as 5 of them recovered, and 2 died, giving a mortality of 39 per cent. In the year 1933, the results were still more satisfactory. 15 cases were treated with sera manufactured in Calcutta, both intrathecally and intravenously and no less than 13 survived and the mortality was 14·3 per cent. All these patients also received Schering's urotropin, intravenously every day as a routine measure.

*Dose of Serum.*—The quantity of serum to be given intrathecally varies in different individuals and depends on how much cerebro-spinal fluid is withdrawn. On no account serum should be introduced in quantity larger than the amount taken up. Sometimes, the cerebro-spinal fluid comes out under great pressure and even after 100 c.c. have passed out, the rate of flow still remains over 60 drops per minute. In these cases it has been advised to draw out fluid in two or three instalments of 60 c.c. each, and give intrathecally 20 c.c. of the serum. On the other hand, Stitt recommends that the cerebro-spinal fluid should be drained out

till 4 or 5 drops come out in a minute. Personally I have not seen any untoward result by draining up large quantities of cerebrospinal fluid. In my cases when the rate of flow becomes less than 30 per minute, I raise the head and the shoulders a little, with the result that it flows out more quickly and then once the rate flow goes down below 30, it quickly comes down to 9 or 10 per minute, when no more fluid is allowed to come out. 20 to 30 c.c. of serum is then introduced slowly with the head brought down to level position. After this, the head and the shoulders are kept low, and the pelves raised. At the same time 60 to 80 c.c. of serum is given intravenously. The intravenous medication is more urgently indicated if meningococci are found in blood culture. In 1918 Herrie recommended this combined method of medication. The total amount of serum for every individual was an average 100 c.c. intrathecally and 400–600 c.c. intravenously. In Herrie's experience the mortality where serum was given intrathecally was 34 per cent. but by combined intravenous and intrathecal methods the mortality was 14·8 only. My own experience was entirely corroborative of Herrie's.

*Cisternal Route.*—In some cases, where there was arrest of clinical improvement due to the impairment of communication between ventricular and spinal fluids, cisternal puncture was done and serum introduced by this route. Lenkowicz found that the spinal fluid became thick owing to the increase of protein contents. He found that communication of ventricular and spinal fluid was arrested when the protein contents of spinal fluid becomes more than 5 times that of ventricular fluid. In such cases, where lumber route gives a dry puncture, cisternal puncture should be done. Vast numbers of cases were treated by this route in the Campbell Medical School of Calcutta with success.

*Serum Meningitis.*—In two cases, patients were seen to relapse after 10 or 12 days of apparent improvement and became delirious comatose again. The temperatures, which were normal, shot up again to 101° or 102°. Both these cases complained of joint pains and itching sensations all over their bodies. This led me to suspect serum meningitis in which urticaria is generally present. But the dark complexion of these patients perhaps masked these appearances in their skin. Injection of adrenalin and calcium gluconate quickly restored the temperature to normal and the patients gradually recovered.

In cases of doubt, lumber puncture should be done. In serum meningitis, the fluid is usually clear and the poly-morphous cells do not show meningococci. There is increased albumen but glucose is not diminished as in tubercular meningitis which shows a relapse of these bad signs after apparent improvement.

*Value of Vaccines.*—There is no doubt that those cases which show tendency to become chronic are quickly benefited by exhibition of vaccine. The antibodies are rapidly developed. Taylor is of opinion, however, that the antibodies do not pass into the cerebrospinal fluid.

*Value of Hexamin.*—Osler recommends 30 to 50 grains of hexamin daily as prophylactic measure. In all my cases, urotropine was given as a routine measure, both *per os* and intravenously. Dr. P. Banerjee of Howrah got excellent results with cylotropine in five cases.

*Value of Mercurochrome.*—0·1 per cent. solution of mercurochrome was tried intrathecally with doubtful results.

*Complications.*—Respiratory disturbances may appear in some cases, which are best treated with Tr. Ephedra or adrenalin. In a few cases arthropathies develop for which serum may be injected into the joints. I would strongly recommend vaccine in these cases.

*Conclusions.*—(1) Besides general hygienic measures, prophylaxis by means of vaccine may be attempted.

(2) Serum should be given both intrathecally and intravenously.

(3) Local brands of serum are strongly recommended.

# Obituary.

## Prof. Willem de Sitter (1872-1934).

WE regret to record the death of Prof. Willem de Sitter, one of the leading astronomers of the present time. He was born on the 6th May 1872, prosecuted his University studies at Groningen and worked in the astronomical laboratory there till 1896. Later he was appointed Professor of Astronomy at Leyden, a famous place for its old astronomical laboratory and then became the director of the laboratory in the year 1918. In the years 1917–1918 he contributed three papers to the *Monthly Notices of the Royal Astronomical Society* expounding the then new theory of gravitation and introducing his conception of the Universe, the "de Sitter Universe". His researches were the nuclei of further work in cosmology but "he was the man who discovered a universe and forgot about it". For about ten years after, he devoted himself to the reorganisation of the laboratory at Leyden. In 1931, he was invited to deliver the Lowell lectures on "Cosmology" at Boston.

His last paper was "On the foundations of the theory of relativity, with special reference to the expanding universe" published in the last November issue of *Proc. Kon. Akad. Wet.* He died on November 19 and in him the astronomical world has lost an eminent scientist.

# Science and Crime.

THE prospect of a reorganisation of the police force lends point to the necessity, emphasised by Mr. H. T. F. Rhodes in a recent paper before the International Faculty of Sciences, for a strengthening of the scientific branch of the criminal investigation department. Criminals are becoming more and more trained scientists, with a knowledge of many of the things that can be or have been discovered by research, and crime detection therefore tends to become increasingly a matter of chemical and physical analysis. There is no reason why a body of chemists and physicists attached to the police and permanently engaged in police work should not become so expert as to rival the legendary Sherlock Holmes in the ingenuity of their methods. In the provinces as well as the Metropolis there is an increasing recognition of the need for scientific methods; for example, since Mr. Rhodes read his paper, we notice that the latest scientific appliances for the prevention and detection of crime have been included in the equipment of the new police headquarters at Newcastle-on-Tyne.

The chemist is a professional detective in his daily work, and in the realm of crime detection he may be relied upon to apply himself to his investigations with the same impartiality as he displays in his own laboratory. There is no need to divide the "technical police" into two departments, one for the prosecution and one for the defence, as has been suggested in some quarters, for the whole department, like the police force itself, should be quite capable of sifting the evidence without fear or favour and submitting it to the tribunal which has to decide the issue. All that is necessary is to ensure that the scientific police are recruited with the utmost care. The personnel must not be chosen from the young and inexperienced but from those who have achieved some eminence in scientific investigation. We commend this aspect of the matter to the attention of the official bodies, the Institute of Chemistry, the Institute of Physics and the British Association of Chemists.

## Letters to the Editor.

### Seismometric Study of the North Bihar Earthquake of January 15, 1934 and its Aftershocks.

IN a note on "The Focal Region of the North Bihar Earthquake of January 15, 1934", published in the last May issue of *Current Science*,[1] it was pointed out that the phases P, $\overset{*}{P}$, $\overline{P}$ and S, $\overset{*}{S}$, $\overline{S}$ were identifiable on the records of the Indian seismic stations lying within an epicentral distance of about 1000 kms. Since then it has been possible to obtain and study the original seismograms of some Indian stations and also photostat copies of records from the neighbouring extra-Indian stations within a distance of 6000 kms. It may be of interest to note that the phase $\overline{P}$ appears to be identifiable on the seismograms of such distant stations as Bombay ($\Delta$ =1610 kms.), Medan ($\Delta$ =2877 kms.), Batavia ($\Delta$ =4255 kms.) and Amboina ($\Delta$ =5617 kms.). As far as the present writer is aware the phase $\overline{P}$ has not been detected on the seismograms of any previous earthquake shocks at epicentral distances greater than 1000 kms. If the author's reading of the seismograms of the great North Bihar Earthquake is correct, the observation of $\overline{P}$ to a distance of at least about 6000 kms. would be an useful addition to the existing knowledge of the time-distance curve of this seismic phase. Another interesting feature of the seismograms of the great shock is that the incidence of the primary wave with definite big impetus (iP) was preceded by emergent small tremors (eP) of a few seconds' duration. The phases eP and iP are seen clearly on all the available records. This character of the P-incidence has also been

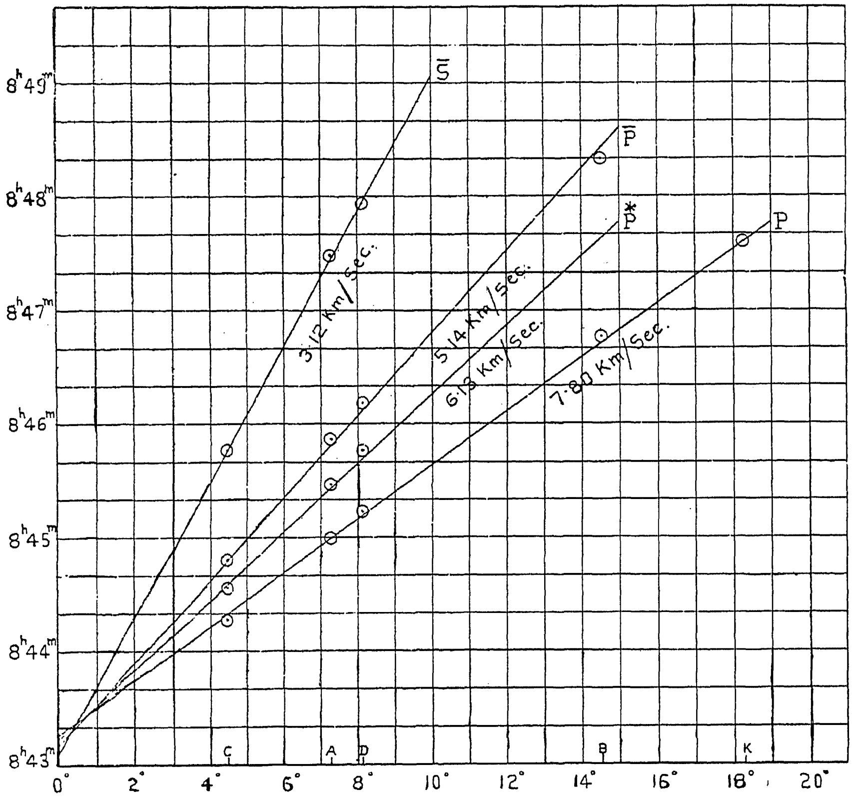


**Fig. 1.** Jan. 15, 1934.
*Epicentre:* Lat. 26° 36′N., Long. 86° 12′E.
*Origin Time:* 8h 43m 16s (G.M.T.) (eP).

[1] *Curr. Sci.*, 1934, **2**, 419.

noted independently in the tabulations of the shock by such distant stations as Hongkong, Nanking and Kew. The duration of the fore-running tremors (eP) is within 6 to 8 seconds at different stations, and may be regarded as constant at all distances. This seismographic observation may be explained by supposing that the major failure which led to the great shock was preceded by a minor failure by about 6 to 8 seconds. The epicentral region of the great shock of January 15 is located near Lat. 26·6° N. and Long. 86·2° E. with origin time of eP as 8 h. 43 m. 16 s. G.M.T. The time-distance curves of the phases P, $\overset{*}{P}$, $\bar{P}$, S, $\overset{*}{S}$, $\bar{S}$ of the great shock of January 15 are given in Fig. 1. Similar curves have also been obtained for the aftershocks of January 16 and 19 (Figs. 2 and 3). The average velocities ($\alpha$) of the

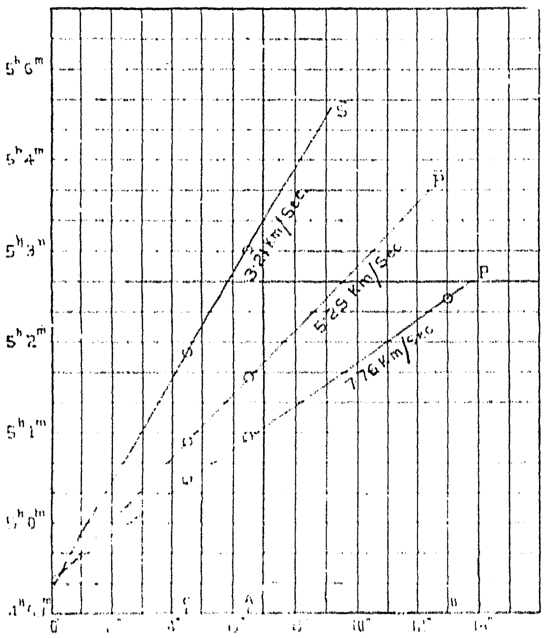


**Fig. 2.** Jan. 16, 1934.
*Epicentre:* 26° 12′N., 85° 18′E.
*Origin Time:* 4h 59m 23s. (P).

three longitudinal waves and those ($\beta$) of the three distortional waves calculated from the seismic data of the North Bihar shocks are:

| | $\alpha \times 10^{-5}$ (C.G.S.) | $\beta \times 10^{-5}$ (C.G.S.) |
|---|---|---|
| Upper layer (Granitic) | 5·23 ($\bar{P}$) | 3·17 ($\bar{S}$) |
| Intermediate layer (Basaltic) | 6·24 ($\overset{*}{P}$) | 3·72 ($\overset{*}{S}$) |
| Lower layer (Ultra-basic) | 7·78 (P) | 4·26 (S) |

The bulk-modulus K corresponding to the above velocities are:

$$K/P = (\alpha^2 - \tfrac{4}{3}\beta^2) \times 10^{10} \text{ C.G.S.}$$

| | | |
|---|---|---|
| Upper layer | .. | 14·0 |
| Intermediate layer | .. | 20·5 |
| Lower layer | .. | 36·3 |

These values of bulk-modulus when compared with the laboratory determinations of

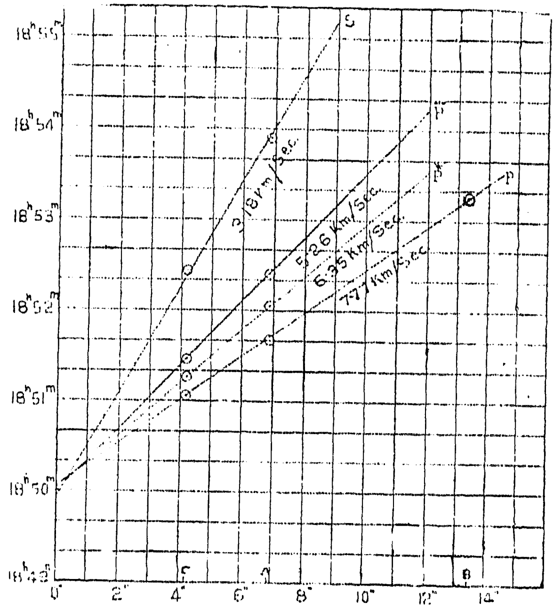


**Fig. 3.** Jan. 19, 1934.
*Epicentre:* 26° 12′N., 85° 36′E.
*Origin Time:* 18h 50m 2s. (P).

elastic constants of Obsidian, Granite, Diorite, Basalts, Dunite, etc., at probable temperatures and pressures at the different layers may throw some light on the constitution[2] of the outer crust of the earth in Bihar. An extrapolation of the time-distance curves of P, $\overset{*}{P}$, $\bar{P}$, S, $\overset{*}{S}$, $\bar{S}$ to the origin show that the apparent delay in start of $\bar{P}$ with respect to $\bar{S}$ is 3·3 secs., that of $\overset{*}{P}$ with respect to $\bar{P}$ is 1·5 secs., and that of P with respect to $\overset{*}{P}$ is 3 secs. From the foregoing data the focal depth of the North Bihar shocks is calculated[3] to be about 13 kms. The thickness of the upper layer is estimated to be 13·7 kms., and that of the intermediate layer as 22·2 kms. The focal depth and the thickness of the upper layer suggest that the major failure leading to the

[2] *The Earth*, by Jeffreys, pp. 101-102.
[3] *Loc. cit.*, pp. 97-98.

disastrous earthquake of January 15 occurred near the boundary of the upper and intermediate layer of the earth's crust. A detailed seismometric study of the North Bihar shocks will be published elsewhere.

S. C. ROY.

Colaba Observatory,
Bombay,
*December 28, 1934.*

### Renoflavin and Vitamin $B_2$.

SINCE we obtained renoflavin from ox-kidney extracts,[1] we have been examining its vitamin $B_2$-potency by observing its growth-promoting effect, at different stages of purification of the flavin, on rats maintained on a "Vitamin B"-deficient diet, supplemented by a preparation of vitamins $B_1$ and $B_4$, obtained from yeast according to Peters' method. It has been found that fairly concentrated fractions of the pigment are unable to promote good growth even in doses considerably larger than the effective dose, reported by Kuhn. In the quest of a possible missing factor we have found that the rate of growth could be very appreciably enhanced by supplementing relatively small doses of the flavin concentrates with the filtrate, left after adsorption of the ox-kidney extract with Fuller's earth, which we had previously heated at pH 9·0 for half an hour in an autoclave at one atmosphere pressure in order to destroy traces of vitamins $B_1$, $B_4$ and the flavin. This would indicate an apparent complexity of what is regarded as vitamin $B_2$ and would show that one of the factors involved, other than the flavin, is a relatively heat- and alkali-stable substance.

B. C. GUHA.
H. G. BISWAS.

Biochemical Laboratory,
Bengal Chemical & Pharmaceutical
Works, Ltd., Calcutta,
*November 28, 1934.*

### The Occurrence of *Isœtes* in India.

So far only one species of *Isœtes* (*I. coromandelina* L.) has been reported to be found in India. It grows very commonly on the Coromandel Coast; Fyson collected it from Madras and Kashyap from near Seven Pagodas (Madras), as has been recorded by Pfeiffer.[2] Another place from where it has been collected is Serampore in Bengal and that was by Griffith, as stated by Prain.[3] Ekambaram and Venkatanathan[4] have also referred to only these two places. It would, therefore, be of some interest to record that the writer collected a species of the plant on the 14th October, 1930, from a shallow pond about a mile or so away from the Benares Hindu University grounds. Subsequently more places were found where it grew. Collections have been made from time to time from various localities, and it has been ascertained that this plant grows very abundantly within a radius of ten miles or so from this University.

The Benares species resembles *I. coromandelina* in practically all respects except that the former has got the preponderance of four-lobed stocks which character has been described by Pfeiffer to be a rarity.

Y. BHARADWAJA.

Department of Botany,
Benares Hindu University,
*December 1, 1934.*

### A Preliminary Note on the Occurrence of Liane Type of Structure in the Stem and Root of *Thylacospermum rupifragrum*, Schrenk.

*Thylacospermum rupifragrum*, Schrenk. is a plant of the elevated and arid regions of Western Tibet and is characterised by an extremely compact cushion habit. Its young stems and roots possess the usual structure characteristic of dicotyledons; the primary organisation and early secondary growth are of the normal type—the normal or primary cambium developing bast on its outside and wood on its inside in a uniform manner. During later stages of development of both the stem and root some cells of wood parenchyma assume meristematic activity and so constitute strips of secondary cambium on the inside of the normal vascular cylinder. The secondary cambial strips develop xylem on the side facing the xylem formed from the primary cambium and phloem on the side removed from it. Sooner or later vascular tissue resulting from the activity of the different strips becomes distinct from the original vascular tissue by crushing the

[1] Guha and Biswas, *Curr. Sci.*, 1934, **2**, 474.

[2] Pfeiffer, N. E., "Monograph of the *Isœtaceæ*," *Ann. Miss. Bot. Gard.*, 1922, **9**.

[3] Prain, D., "The Vegetation of the Districts of Hughly—Howrah and the 24-Pergunnahs," *Rec. Bot. Surv. Ind.*, 1908, **3**.

[4] Ekambaram, T., and Venkatanathan, T. N., "Studies on *Isœtes coromandelina* L.," *Journ. Ind. Bot. Soc.*, 1933, **12**.

surrounding cells. Thus internal vascular strands carrying on their independent growth are differentiated. With the continued growth of the axis and without the cessation of the activity of the normal cambium more and more strips of secondary cambium appear in the rest of the xylem formed from the primary and secondary cambiums. The continued growth of the wood parenchyma ultimately splits the vascular cylinder into numerous irregular strands in a manner similar to that found in many lianes, *e.g.*, *Bauhinia*, etc. This type of structure is generally considered to be correlated with the habit of lianes, but here it is found in just a reverse type of plant—a species with a very stunted stem.

PRAKASH CHANDRA JOSHI.
Botany Department,
University of the Punjab,
Lahore,
*January 2, 1935.*

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### A Note on the Occurrence of a Smut on Two Indian *Selaginellas*.

THE occurrence of a fungous disease on the Peteridophytes is a comparatively rare phenomenon. In October, 1932, we collected two species of *Selaginella*, *S. chrysócaulos* Spr. and *S. chrysorrhizos* Spr., from Rajpur and Mussoorie respectively. On an examination of the material we found the presence of dark brown irregular patches on the leaves and stems of both the species. The fungus was at once identified as one of the Ustilaginales, but there was some difficulty in the generic determination. On referring to the previous literature on the subject we found that Mr. T. C. N. Singh[1] had already reported the occurrence of a species of *Entyloma* (?) on *S. chrysocaulos*, the material of which had been collected by Dr. B. Sahni while on his way back from Mussoorie to the Plains. From an examination of some of this material, kindly sent to us by Prof. Sahni, we think that the two forms are identical. The identification of the genus is still a matter of some doubt and will probably remain so till the spores have been germinated, but judging from the sorus and spore morphology it bears greater resemblance to *Melanotænium* than to *Entyloma*. One of the differences mentioned between the two genera is the presence of highly coloured to brownish spores in *Entyloma*, while those of *Melanotænium* are of a distinctly darker shade.[2] As reported by Singh, hyphæ are not of frequent occurrence, but in our material (some of which had younger sori) we often came across the more or less finger-like haustoria present in the cells of the host.

In conclusion, we wish to offer our sincere thanks to Dr. E. J. Butler, of the Imperial Mycological Institute, Kew, for having given us the benefit of his advice with regard to the identification of the fungus.

P. MAHESHWARI.
VISHWAMBHAR PURI.
Agra College,
Agra,
*December 27, 1934.*

[1] Singh, T. C. N., "A note on the occurrence of a smut on *Selaginella chrysocaulos*," *New Phytol.*, 1930, **29**, 294-296.

[2] Clements and Shear, *The Genera of Fungi*, New York, 1931.

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### A Virescent-White Mutation in Rice.

IN the early strain of Kolamba, K 79, a seedling with white leaves was discovered last season. As the seedling displayed unique appearance it was potted off and reared carefully. Periodic examination of the growth of the seedling showed that the new leaves were invariably devoid of chlorophyll presenting whitish appearance, but very gradually changing to greenish colour, the colour developing from tip downward. The seedling was normal in fertility.

During the current season about 400 seedlings of the white mutant were raised and all of them were like the original plant. In due course a number of seedlings of the mutant and the normal parent strain were transplanted in the field for agronomic comparison. The results are as below:

| Character | Mean No. of days to flower from sowing | Mean height of plants cm. |
|---|---|---|
| K 79 .. | 90·96 ± 0·30 | 118·58 ± 1·28 |
| Mutant .. | 95·66 ± 0·62 | 82·25 ± 2·90 |

| Character | Mean Panicle length cm. | No. of tillers | Mean yield per plant gm. |
|---|---|---|---|
| K 79 .. | 28·75 ± 0·32 | 5·83 ± 0·18 | 19·04 ± 0·76 |
| Mutant .. | 19·46 ± 0·78 | 2·50 ± 0·25 | 2·51 ± 0·34 |

It will be seen that the virescent-white plants are inferior to K 79 in panicle length, height, number of tillers and in yield, although they are late by about five days. The differences in all cases are highly significant. The slow growth of the virescent-white plants is due to very slow rate of chlorophyll formation. Colourmetric readings show that the mutant plants have about 66 per cent. chlorophyll compared to K 79.

The writer is not aware of any previous report of this type of chlorophyll mutation in rice, although albino, yellow and striped chlorophyll mutations have been reported.

The new type has been crossed with the parent K 79 to determine the mode of inheritance.

B. S. KADAM.

Rice Breeding Station,
Karjat, Kolaba,
*November 1934.*

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## On the Increase of Mutation Frequency following Inter-Specific Hybridization in *Nicotiana*.

By Prof. Dontcho Kostoff,
*Institute of Genetics, Academy of Sciences of U.S.S.R., Leningrad.*

THE hybrids produced between *Nicotiana Sanderæ* ($n=9$) with certain other far related *Nicotiana* species often formed some white stripes in the flowers. Every year for the last eight years I raised *N. Sanderæ* with various flower colours (whitish, pink, red, and the like, of the various intensities of red-violet colours), and have seen this species growing in many gardens, but only three times have I seen the kind of stripings as those observed in some of its $F_1$ hybrids.

The red flowering *N. Tabacus* var. *sanguineæ* ($n=24$) behaves in some crosses like *N. Sanderæ*. It has blood-red flowers.

In the crosses of the red flowering *N. Sanderæ* and *N. Tabacum* with the white flowering species [*N. alata* ($n=9$), *N. sylvestris* ($n=12$), *N. suaveolens* ($n=16$), *N. noctiflora* ($n=12$), *N. Tabacum alba* ($n=24$), etc.] and with greenish-yellowish flowering ones [*N. rustica* ($n=24$), *N. paniculata* ($n=12$), *N. Langsdorffii* ($n=9$), *N. glauca* ($n=12$)], red behaves like a dominant, in some combinations, however, incomplete dominance occurs too.

The stripings that appear on the $F_1$ hybrids usually affect single flowers. They appear with one or more than one white stripe on the red or pink background, or with pink stripes on a red background. The size of the affected areas vary very greatly. The largest white area I found was about 1 sq. cm. covering about 1/6 of the whole corolla (five petals), while the smallest ones represent only a small group of several cells. Sometimes we found red spats or stripes (reverse mutations) in the region of the white ones. Some flowers have only one stripe, while others have more than sixty (Fig. 1). The more detailed observations made on several hybrids are summarised in Table I. Other hybrids are not studied in detail.

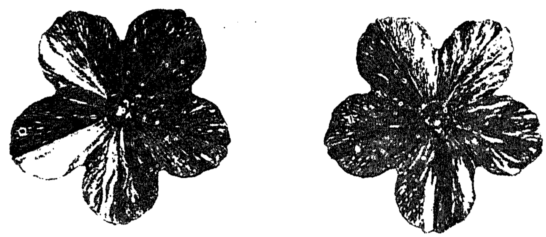

**Fig. 1.**

Striped flowers from a hybrid *N. noctiflora* × *N. Sanderae.*

It should be mentioned here that *N. Sanderæ* plants are often heterozygous and some of the $F_1$ hybrids, where *Sanderæ* participates, differ to a certain extent. Different genotypes of *N. Sanderæ* do not show the same degree of variegations. The most striking results were produced in some of the crosses between *N. noctiflora* (from the Harvard University, syn. *N. Cavanilesii*) and red flowering *N. Sanderæ*. Drawings of two extreme types are given in Fig. 1. We have the impression that the older hybrids have many more striped flowers, and the affected areas are much greater in the older hybrids than in the younger ones.

The stripings of the hybrid *N. Tabacum* var. *sanguineæ* × *N. alata* (white flowering) usually represent pink stripes on the red (reddish) background. But it was found

TABLE I.

| No. | Maternal species | Flower colour of the maternal plant | Paternal species | Flower colour of the paternal plant | Flower colour of $F_1$ hybrids | Number of the flowers of $F_1$ studied | Number of the flowers of $F_1$ with one stripe | Number of the flowers of $F_1$ with two stripes | Number of the flowers of $F_1$ with more than two stripes | Number of the flowers of $F_1$ with more than twenty stripes | Flowers with secondary (red) reverse stripes on the background of the primary (white) stripes (reverse mutations) | Special remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *N. Tabacum* var. *sanguineæ.* ($n$ 24) | Carmin red | *N. alata* ($n$ 9) | White (cream-like) | Red-pinc | 95 | 21 | 5 | 2 | .. | .. | Some of them studied during the second year |
| 2 | *N. Rustica* var. *humilis* ($n$ 24) | Greenish-yellowish | *N. Sanderæ* ($n$ =9) | Red | Red | 37 | 12 | 6 | 4 | .. | 1 (+1 ?) | One doubtful |
| 3 | *N. paniculata* ($n$ 12) | ,, | *N. Sanderæ* | ,, | ,, | 53 | .. | .. | .. | .. | .. | |
| 4 | ,, | ,, | *N. Sanderæ* but another genotype | ,, | ,, | 32 | 2 | 1 | .. | .. | .. | |
| 5 | *N. noctiflora* ($n$ 12) | White | *N. Sanderæ* | ,, | ,, | 8 | .. | .. | 5 | 3 | 8 | |
| 6 | *N. noctiflora* | ,, | ,, | ,, | ,, | 6 | 1 | .. | .. | .. | .. | Another hybrid |
| 7 | ,, | ,, | ,, | ,, | ,, | 5 | .. | 1 | 3 | 1 | 1 | ,, |
| 8 | ,, | ,, | *N. alata* | White | White | 21 | .. | .. | .. | .. | .. | |
| 9 | *N. Tabacum* var. *alba* ($n$ 21) | ,, | ,, | ,, | ,, | about 30 | .. | .. | .. | .. | .. | |

that a part of the pink stripes changed into white in 11 flowers out of about 75.

It should be noted here that species hybrids produced from white flowering species, formed only white flowers (*N. Tabacum alba* × *N. alata*, *N. Tabacum alba* × *N. sylvestris*, *N. noctiflora* × *N. alata*, *N. suaveolens* × *N. alata*).

Species hybrids of *N. Tabacum* produced with far-related species like *N. alata* and *N. Sanderae* show striping (many of them, but not all of them), while those produced with closely related species, like *N. sylvestris* (*N. Tabacum sanguineæ* × *N. sylvestris*) do not show any stripings. At least I have not observed such. It should be added here that *N. sylvestris* is very closely related to *N. Tabacum*; there are evidences that it has participated in the origin of *N. Tabacum*.

*N. Tabacum* crosses easily with many varieties of *N. rustica* (greenish-yellowish flowers) but no variegations were observed in the $F_1$ (*rustica* × *Tabacum*) hybrids. The latter cross easily with the parental plants (Kostoff, 1930)[1] and from such backcrosses triploids and chromosomal aberrants are produced, while the hybrids *N. Tabacum* × *N. alata*, *N. Tabacum* × *N. Sanderæ*, and *N. rustica* × *N. Sanderæ* cannot be crossed back either to the parental plants or to some other third species, and all these three hybrids produced striped flowers.

*N. Sanderæ* hybrids do not form striped flowers when the other component species are closely related to *N. Sanderæ*, as for example, in the crosses *N. Sanderæ* × *N. alata*, *N. Sanderæ* × *N. Langsdorffii*, *N. Sanderæ* × *N. longiflora* ($n$ =10), *N. Sanderæ* × *N. plumbagenifolia* ($n$ =10), etc., while the hybrids from the far-related species: *N. rustica* × *N. Sanderæ*, *N. Paniculata* × *N. Sanderæ*, *N. noctiflora* × *N. Sanderæ*, etc., do form striped flowers. The first two hybrids are fully fertile, the next two are partially fertile when crossed back to

[1] Kostoff, Dontcho, "Ontogeny, Genetics and Cytology of *Nicotiana hybrids*," *Genetica*, 1930, **12**, 33–139.

*Sanderæ*, while the last three are sterile. Only a single plant was produced after numerous back-crosses (*N. noctiflora* × *Sanderæ*) × *alata*, and it was a triploid one with 30 somatic chromosomes (12+9+9). A transitional hybrid seems to represent *glauca* × *Sanderæ* in this respect. Only a few times we have seen single stripes on the flowers of $F_1$ hybrids of these two species. When the $F_1$ (*glauca* × *Sanderæ*) is crossed back to *N. Sanderæ* or to *N. Langsdorffii*, hybrids are produced with difficulties.

The appearance of the white stripes on the species hybrid cannot be due to a loss of chromosome or chromosomes, because reverse changes from white to red occur too, and the normal chromosome numbers, characteristic for the hybrids, were counted in the pollen mother cells of $F_1$.

It should be noted here that stripings reported above on the species hybrids cannot be identified or mixed up with the variegations or stripings often caused by virus diseases. The cases here reported were observed on healthy plants. We have often observed variegations and stripings on the flowers of some of the red flowering segregates of *N. triplex* (the triple fertile hybrid, *Tabacum* × *sylvestris* × *Rusbyi*), caused by mosaic disease. But they differ in the appearance and the kind of distribution of the colour.

The observations here reported show that the dominant genes for colour in some species hybrids produced from relatively far-related species changes to their recessive allelomorphs (white) more often in the species hybrids than in the pure species. Reverse changes (mutations) occur, too, with relatively great frequency, *i.e.*, mutations from the recessive to the dominant type. The hybridization seems to produce new internal conditions in certain cross combinations, where a "stable" gene behaves like a "mutable" one (compare the mutable genes in *Delphinium* described by Demerec, 1931).[2]

The hybrids represent a new system in which the mutation rate proceeds with a different frequency from that in the original species. The same may be true for the species originating from hybridization, especially for the amphidiploid ones. The author is indebted to Dr. H. J. Muller for criticism and to N. Dogadkina for making the drawing.

[2] Demerec, M., "Behaviour of two mutable genes of *Delphinium Ajacis*," *Jour. Genet.*, 1931, **24**, 179-193.

## Ecological Studies of Pink Bollworm (*Platyedrs gossypiella*, Saunders).*

By M. Afzal Husain, M.A. (Cantab.), I.A.S., M. Haroon Khan, B.Sc. (London), A.R.C.S., and Nazir Ahmad, M.Sc.

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THE Pink Bollworm—a cosmopolitan pest of cotton—shows in the Punjab a peculiar variation in the density of its population. In the south-eastern, sub-montane and the central regions of the province it is so abundant as to be regarded a 'major pest', while in the Canal Colonies and the western districts—the main cotton-growing tracts—it is not a 'pest' and is, in fact, scarce. Evidently, therefore, an abundant supply of its favourite food—the cotton crop—is not the only factor which determines the density of its population.

During the last few years an attempt has been made to analyse the factors which influence the incidence of this pest, in the Punjab. It has been determined that at Rohtak, situated in the south-eastern Punjab—a region of high incidence—the number of eggs laid by *P. gossypiella*, under natural conditions, throughout the period of its activity, is much higher than at Lyallpur, situated in the Canal Colonies—a region of low incidence. Thus at Rohtak during July, when the attack normally starts, the average number of eggs laid per female, based on the figures of three years (1931-33), varied from 13 to 49, while at Lyallpur this number varied between 2 and 7 only. The maximum number of eggs laid by a female was 326 at Rohtak and only 75 at Lyallpur. Later in the season too, during August, September and October, the average oviposition at Rohtak varied between 30 and 89, and at Lyallpur between 3 and 61 (only once in three years it went to 61, otherwise it was never above 40).

* The researches carried out are being financed by the Indian Central Cotton Committee. The generosity of the Committee is gratefully acknowledged.

Under experimental conditions it has been established that temperature, acting on the pupæ and the adults, largely determines the egg-laying of these moths. It has been determined that the optimum temperature for the full development of the gonads and the maximum deposition of eggs ranges between 75°–82° F. Thus the moths emerging from the pupæ kept at 75° F.—a favourable temperature—and exposed to the same temperature, gave on an average 98 eggs per female, but the moths bred under similar condition of temperature and kept at 95° F. —an unfavourable temperature—on an average laid only 23 eggs. On the other hand, the moths emerging from the pupæ kept at 92° F.—an unfavourable temperature—and exposed to the same temperature, hardly laid an egg, and even when exposed to a favourable temperature—75° F. gave no more than 7 eggs per female.

Further, it has been found that over 80% of the moths emerging from the pupæ kept at a temperature of 92° F. or above, have not the capacity of procreation. The reason for this is that the males bred at such high temperatures, although otherwise normal, are devoid of fully developed sperms and hence incapable of fertilising the females.

The influence of humidity has not been so thoroughly worked out, but the results obtained show that it influences oviposition in much the same way as temperature. A high relative humidity, about 70·95%, has been found to be very favourable for the development of the gonads and the deposition of eggs.

On the basis of the results obtained under controlled conditions, a correlation between the biotic potential and the environmental resistance, *i.e.*, between the initial capacity for increase in numbers possessed by this insect and the resistance offered by temperature and humidity, under natural conditions, has been established. A study of the three years' meteorological data which, unfortunately, are very incomplete for an ecological investigation, has shown that oviposition was highest when the mean maximum temperature acting on the pupæ and the adults was about 90° F., the mean minimum 72° F. and the relative humidity 70% or over at 8 hours.

In places where the incidence of attack is high, the temperature and humidity, during the main period of the activity of the pest—July to October—approximate closely with those favourable for procreation, while in the Canal Colonies and the western districts, where the pest is present in insignificant numbers, both the maximum and the minimum temperatures are much higher and the humidity much lower. These adverse climatic conditions increase the sterility of the males on the one hand, and interfere with the process of egg-laying by the females on the other, thereby limiting increase in numbers. It is not, therefore, as one would imagine, only through the destruction of the individuals born that population is restricted, but perhaps, the restriction in the numbers of the individuals produced is more important. In other words, nature besides being 'red in tooth and claw' also controls birth.

The results obtained afford a basis for forecasting the intensity of Pink Bollworm attack in any particular region. To be able to do so, however, the meteorological conditions during the cotton-growing season and the time at which the moths emerge from the 'long-cycle', *i.e.*, hibernating larvæ should be fully known. If the emergence of moths coincides with the fruiting of cotton, and the climatic conditions are favourable for their procreation, then the pest will be serious, as is the case in Egypt, Mexico, Texas and the United Provinces of India. If, on the other hand, the emergence coincides with the fruiting of cotton but the climatic conditions are unfavourable, as at Hyderabad (Sind), the Canal Colonies and the Western Punjab, then the progeny of this pest will be limited in numbers and it will not become serious. At Surat (Bombay) and Wad Medani (Sudan) where the emergence takes place before the fruiting of cotton and most of the progeny destroyed because food is not available, the pest cannot be serious. Lastly in Kenya, Italian Somaliland and Coimbatore (Madras), where the pest remains active throughout the year it will not be serious because most of its progeny would be destroyed during the non-cotton season when the food supply is limited only to the few alternative host plants.

This short note is contributed to stimulate ecological research in this country, as research on these lines provides a sure foundation for scientific pest control.

# The Hyolaryngeal Apparatus of Pelobatidæ.

By L. S. Ramaswami,
*Department of Zoology, University of Mysore, Central College, Bangalore.*

I HAVE recently been examining the cranial anatomy of *Pelobatinæ*, *Megalophrynæ* and *Sooglossinæ* when through the courtesy of Dr. G. K. Noble, I came into possession of a male specimen of *Scaphiopus hammondii*.* It appeared to me that an examination of the morphology of the larynx of this batrachian might reveal certain features not hitherto recorded, and this note gives a brief account of the topographical relations of the different cartilaginous elements of the larynx of *Scaphiopus* with one another and with those of the hyoid apparatus. On referring to the available literature on the subject of the Anuran larynx, I find that G. A. Boulenger[1] while giving a brief reference to the hyoid apparatus of *Scaphiopus solitarius* in his paper on the anatomy of this anurous amphibian makes no allusion to the structure of the larynx. I have carefully examined the larynx of *Scaphiopus hammondii* sent to me by Noble, and I notice that the hyolaryngeal apparatus of this species differs from that of the other allied forms such as, *S. holbrookii*,[2] *Pelobates fuscus*,[3] *Megalophrys nasuta*,[4] *M. montana*,[4] *M. hasseltii*,[4] *M. feæ*,[5] and *M. bœttgeri*,[6] in material points. I am indebted to the authorities of Raffles Museum, Singapore and of the Indian Museum, Calcutta, for specimens of *Megalophrys nasuta* and *Megalophrys major* respectively which I have studied for purposes of comparison. I take this opportunity of thanking Dr. Noble for his kind presentation of a specimen of *S. hammondii*.

The hyoid of *S. hammondii* offers certain points of anatomical interest and as Noble[2] makes no reference to this structure in his description of *S. holbrookii*, I am unable to compare the hyoid of these two species. The anterior processes of the hyoid in *S. hammondii* do not meet in the median line as in the case of *Pelodytes*,[7] but stand well apart with a wide median space between the processes. In other respects the hyoid of *S. hammondii* conforms to the general plan of this structure in the species examined of the family *Pelobatidæ*. If this apparatus of *Pelobatinæ* is compared with that of *Megalophrynæ*, we notice that the presence of a conspicuous foramen laterale at once distinguishes the former from the latter. In this connection it may be remarked that the figure of the hyoid of *Pelobates fuscus* as given by Parker[3] does not reveal the presence of a foramen laterale; on the other hand Ridewood[7] who has described the same structure prominently figures it. Finally, I may observe that *Scaphiopus*

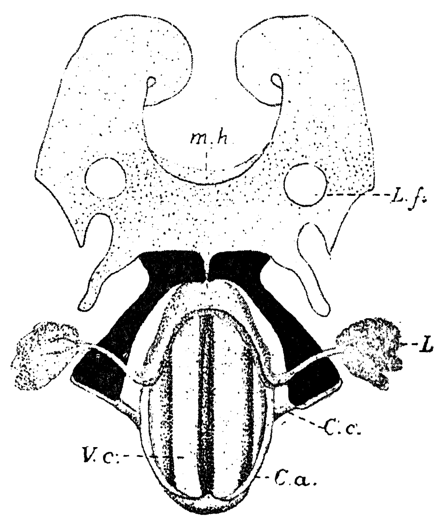


**Fig. 1.**

Hyolaryngeal apparatus of *S. hammondii* (♂). × 3.

| | |
|---|---|
| *c. a.* | Cricoid annulus. |
| *c. c.* | Cartilaginous connection between the cricoid annulus and the epiphysis of the posterior cornu. |
| *L.* | Portion of the lung. |
| *L. f.* | Foramen laterale. |
| *m. h.* | Membrane. |
| *v. c.* | Vocal cord. |

* Specimen from American Museum of Natural History, N. Y., No. 19637.

1 Boulenger, G. A., *Proc. Zool. Soc. Lond.*, 1899, 793.

2 Noble, G. K., *The Biology of the Amphibia*, McGraw and Hill. New York and London, 1931.

3 Parker, W. K., *Phil. Trans. Roy. Soc. Lond.*, 1881, **172**, 1.

4 Beddard, F. E., *Proc. Zool. Soc. Lond.*, 1907, 871.

5 Beddard, F. E., *Proc. Zool. Soc. Lond.*, 1911, 393.

6 Frazier, M., *Journ. Morph. and Physiol. Phil.*, 1924, **39**, 285.

7 Ridewood, W. G., *Proc. Zool. Soc. Lond.*, 1897, 577.

*hammondii* resembles the other allied genera in having a reduced hyale and in the bony cornu bearing a fairly well-developed cartilaginous epiphysis.

In a recent paper[8] on the Anuran larynx, Miss Trewavas while describing the vocal organs of *Megalophrys robusta* gives a review of the previous work on this structure in the family *Pelobatidæ*. She generalises that "the most characteristic feature of the larynx is the incompleteness mid-dorsally of the cricoid ring". Moreover in the majority of the anurous forms belonging to this family which have been described, the two œsophageal processes given off from the cardiac end of the cricoids have been noticed. In some species, however, such as *Pelobates fuscus* and *Megalophrys hasseltii*, the larynx is shown by Blume[9] and Beddard[4] respectively without these œsophageal processes. Further, Noble in his book on "The Biology of the Amphibia" gives a figure of the larynx of *S. holbrookii* (p. 169), and indicates the presence of these œsophageal processes but does not mention the sex of the animal investigated by him. From his figure of *S. holbrookii*, the cricoids can be made out to be incomplete, thus conforming to the generalisation of Trewavas alluded to above.

In the specimen of *S. hammondii* examined by me the larynx presents certain structural features which differ from that of other examples investigated by the previous workers. In the first place, the cricoids of *S. hammondii* meet mid-dorsally and fuse to form a complete annulus. A second point of equal interest is the absence of œsophageal processes from *S. hammondii* which occur almost as a rule in *S. holbrookii*, *M. robusta*, *M. nasuta*, *M. montana*, *M. feæ*, *M. bœttgeri* and possibly also in *Sooglossinæ*. In this negative feature, *S. hammondii* resembles *Pelobates fuscus* and *M. hasseltii*. In addition to these interesting characteristics, *S. hammondii* presents a third feature which has not been noticed by the previous investigators in any of the related forms studied by them except in *Pelobates fuscus*.[9] This refers to a cartilaginous process given off from either side of the cardiac end of cricoid annulus which meets and fuses with the epiphysis of the bony posterior cornu of the hyoid. With such attachments to the hyoid, the larynx becomes difficult to be detached. I should point out that in the closely related species *S. holbrookii*, these connections have not been noticed by Noble.[2] The cartilaginous rod connecting the cricoid with the posterior cornu of the hyoid has been noticed in species of *Bufo*, *Pseudopaludicola*, *Oriophrynella* and *Dendrobates*.[8]

I am unable to say whether the presence or absence of œsophageal processes of the cricoid is a sexual feature, for the example I have investigated is a male form. In the family Ranidae[10] the "spina œsophagea" of Gaupp occurs only in the female specimens and the male examples are usually devoid of them. When I drew the attention of Dr. Noble to these marked deviations of *S. hammondii* he wrote to me that he will reinvestigate the material and publish a comprehensive account of the anatomy of the several species of *Scaphiopus*.

Regarding the œsophageal processes of the larynx, I have to point out that *Megalophrys major* [*M. gigas* (Jerdon), *M. major* (Boul)] though agreeing with the other species of this genus in all essential points of the hyolaryngeal apparatus, differs in this important particular, *viz.*, the œsophageal processes have fused posteriorly so as to form a definite secondary annulus.

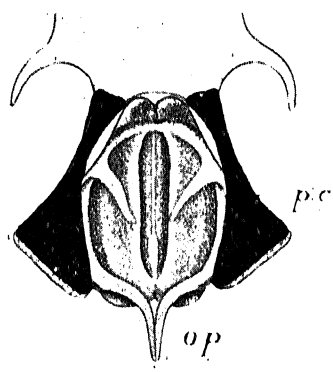


**Fig. 2.**

The larynx of *Megalophrys major* (♂) and a part of the hyoid apparatus. × 3.

*o. p.* Oesophageal process.
*p. c.* Posterior bony cornu of the hyoid.

Miss Trewavas[8] summing up her observations on the hyolaryngeal structure of *Pelobatidæ* (p. 501) writes "a combination of

[8] Trewavas, E., *Phil. Trans. Roy. Soc. Lond.*, 1933, **222**, No. 401.

[9] Blume, W., *Gegen. Morph. Jahrb.*, 1930, **65**, 307.

[10] Ramaswami, L. S., *Half-Yearl. Journ. Mys. Univ.*, 1932, **6**, No. 1, 32.

the following three characters in this apparatus appears to be diagnostic of the family: arytenoid without apical cartilage; cricoid ring incomplete dorsally; hyalia more or less reduced." I agree with her in regard to the first and the last features. From my examination of *S. hammondii* I should modify the second diagnostic feature and state thus: "the cricoid ring is incomplete dorsally except in *S. hammondii* (male)." It would be extremely interesting to examine both sexes of all the species of this genus and also the female form of *S. hammondii.*

## Typhoons and Indian Weather. *

By V. Doraiswamy Iyer.

It was generally thought by early workers on Indian Meteorology that all storms in the Bay of Bengal were formed in the Bay itself. Three storms which entered the Bay of Bengal from the Gulf of Siam in the years 1888 to 1897 led to a modification of this view at the beginning of this century. Two of these, the Port Blair cyclone (November 1891) and the Chittagong cyclone (October 1897), were shown to be continuations of China Sea typhoons by the Rev. Father Algue of the Philippine Weather Bureau. During subsequent years several storms were recognised to have entered the Bay of Bengal from the east, but no systematic attempt had been made to trace them eastwards. The present writer took up this investigation in 1924, and owing to the exigencies of other duties the work was completed only recently.

The typhoons of the western North Pacific Ocean and the China Sea may be divided broadly into two classes, namely, (1) those that, after travelling some distance westwards, recurve either in the sea or near the coast of China to the north and north-east and travel towards Japan; they would consequently have no influence on Indian weather, (2) those which travel in a westerly direction throughout their path in the Pacific Ocean and the China Sea and cross the coast of South China or Indo-China.

The typhoons of the second class recorded between the years 1884 and 1930 are 367 in number; they were examined with a view to find out how many of them had affected weather in India. It is well known that when a travelling cyclone crosses a mountain the cyclonic circulation up to the height of the mountain is cut off leaving a truncated cyclone in the upper air. This cyclonic circulation in the higher regions is transmitted to lower layers on the other side of the mountain, and if the air on that side has suitable conditions of temperature and humidity, the cyclone revives. Otherwise it dies. The process of revival, however, takes time and the cyclone becomes recognisable at the surface only after it has travelled some distance away from the mountain.

The examination revealed that as many as 128 of the typhoons had definitely an influence on Indian weather. Some of them redeveloped into storms or depressions, while others were recognisable only as low pressure waves associated with an increase of rainfall.

A monthly analysis showed that typhoons do not affect the weather in India in the first five months of the year. The few that do so in June are felt only in Burma and Assam. The chief typhoon months are July to November. During July and August as well as in November about a third of the westward moving typhoons affect weather in India, while in September and October nearly 50 per cent. do so. Most of those that come over in the months September to November develop into storms or well-marked depressions.

Looked at from the aspect as to how many of the storms and depressions that occur in the Bay of Bengal have a far eastern origin and are the sequels of typhoons or depressions of the China Seas, we find that the ratio of such storms to the total number in the Bay is one to nine in the months of July and August, one to four in September, one to three in October and one to six in November.

An examination of the tracks of the residual flows over the Indo-Chinese Peninsula with reference to the general circulation both at the surface and in the upper air indicates that they travel with the equatorial easterlies along the climatic front between the moist monsoon current from the south and the dry land winds from the north.

In the months of July and August this front is near Lat. 25°N., as the strong monsoon current, 4 to 5 Km. deep, flows as a southerly or south-westerly current up to this latitude; at greater heights the southerly current is replaced by the equatorial easterlies which also extend to about 25°N. in these months. The typhoon tracks over the Indo-Chinese Peninsula lie between Lat. 20° and 25°N. With the commencement of the retreat of the monsoon in September this front is displaced southwards and there is a corresponding displacement of the belt of tracks of the typhoons over the Indo-Chinese Peninsula, which now lies between Lat. 15° and 22°N.

The winter high over Asia develops in October and northerly winds extend further southwards, and push the front to lower latitudes. The belt of typhoon tracks over the Indo-Chinese Peninsula is also displaced further to the south and now lies between Lat. 10° and 20°N. With the intensification of the Asiatic High in November and the strengthening of the cold winds from the north the typhoon tracks in this month over the Indo-Chinese Peninsula lie between Lat. 15° and 10°N. The typhoons of October and November mostly recurve to the north and north-east in the east of the Bay; they apparently travel with the upper

* From the paper read at Colloquium at Meteorological Office, Poona, on 11th December, 1934.

air current within the first three kilometres and appear to be shallower than the typhoons of July and August. By December winter conditions become established in southern Asia and no typhoon crosses the Indo-Chinese Peninsula; occasional ones, however, travel westwards farther south in about Lat. 8°N.

It has been pointed out by Visher that, although typhoons attain destructive violence to the west of Long. 150° E., they are probably generated much further east as indicated by observations in recent years in the Marshall Islands and in the seas south of the Hawaii Islands. This is not improbable as the line of convergence of the south-easterly trades and the north-easterly trades lies well to the north of the equator in the typhoon months, and extends to the coast of Central America. The typhoons may well be regarded as pressure waves generated in this line of convergence, which travel westwards with the equatorial easterlies, and intensify when they reach more northerly latitudes on approaching the Asiatic continent. If we could draw the tracks of all these low pressure waves in all stages of development, it is probable that we would find that a majority of them have their origin in the East Pacific Ocean and finally recurve into the general westerly circulation of the temperate latitudes in the North Pacific Ocean, China or Upper India.

# Research Notes.

## Über Gewisse Orthogonale Polynome, die Zu einer Oszillierenden Belegungs-Funktion Gehören.

THE properties of some interesting polynomials arising in connection with Legendre's polynomials are treated in this paper (Szego, *Math. Ann.* B. **110**, pp. 501-513). At the same time Szego proves two conjectures of Stieltjes which remained unproved up till the present day. The polynomials that he considers are defined by means of the equation

$$\frac{1}{Q_n(x)} = E_n(x) + a_1 x^{-1} + a_2 x^{-2} + \ldots .$$

where $Q_n(x)$ as usual represents the Legendre's polynomial of the second kind. Then we have obviously the orthogonality relation

$$\int_{-1}^{+1} P_n(x) \quad E_n(x) \quad x^K dx = 0,$$
$$(K = 0, 1, 2, 3, \ldots . n).$$

(Here it is to be observed that the weight-function $P_n(x)$ is highly oscillating.) The two conjectures of Stieltjes which he proves here are: (1) The roots of $E_n(x)$ are all real simple and lie in the interval $(-1, +1)$; (2) The roots of $P_n(x)$ separate those of $E_n(x)$. In this connection Szego remarks that a more general conjecture of Stieltjes is not yet proved and that his methods developed here cannot perhaps be applied to the general case. Some analogous results are also proved for $E_n^{(m)}(x)$ obtained in an analogous manner from the associated Legendre function of the second kind $Q_n^{(m)}(x)$.

K. V. I.

## Über die Kleinsche Theorie der Algebraischen Gleichungen.

IN this very interesting article Brauer (*Math. Ann.*, Band, **110**, Heft IV, pp. 473-500) has perfected Klein's theory in many important directions. It is well known that Klein has established an intimate connection between the solution of an algebraic equation and the "Formen-Problem" of a group (usually the Galois group of the equation) which is given either as a linear transformation group or as collineation group. The Hermite-Kronecker solution of the quintic equation by means of a modular equation of the fifth order (the icosaeder equation) was explained very clearly by Klein by means of this analysis. He and his students have contributed very largely to the theory of the sextic and the septic equation which can perhaps be considered as the most important work in this field since the classical work of Abel and Galois.

The "Formen-Problem" of a group of linear transformations (order $n$) is the determination of a point in the $n$-dimension space in which the linear transformations are supposed to act when the values of the fundamental invariants for the point are known. In an exactly similar manner we can formulate the same for a collineation group. The fundamental problem is that of determining the cases when the solution of an equation can be made equivalent to the "Formen-Problem" of a suitably chosen group (it is usually the Galois-group of the equation). In the case of the linear-transformation-group this problem is completely solved. In a very interesting way Brauer solves this problem for the case of collineation groups also. The first part of the article does not presuppose much knowledge

on the part of the reader but the latter part presupposes some knowledge of the theory of hyper-complex numbers and group characters.

It has already been observed by Klein that in the case of the quintic equation the solution can be reduced to that of the "Formen-Problem" of the icosæder group only if we extend the field of the coefficients by another quadratic irrationality. It has been found by Brauer that in general the extension of the field is indispensable; and the theory of hypercomplex numbers gives us much knowledge about the nature of the irrationalities that we have to adjoin. In § 1, 2, 3 he shews how the solution of an equation and the "Formen-Problem" of a collineation group can be related. The principal result that he proves is dependent upon the theory of factor systems of the representation of groups treated by Schur in *Math. Zeit.*, 1919, **5**. It is 'If $f(x)=0$ is an equation with coefficients out of a field P with its Galois-group G which is one-one isomorph with a collineation group C, then the complete solution of the equation is equivalent to a "Formen-Problem" of C if among the factor systems of C, a system is found which is associated with the unit system (in the sense of Schur, *loc. cit.*).' Here it is shewn that the number of those factor systems that are to be investigated is equal to the index of the group of the inner automorphisms of G with the group of all the automorphisms of G. In § 4 he connects the theory of the solution of the equation with an aggregate of simple normal algebras (or hypercomplex numbers) over P in an independent way. The principal results of § 4 and 5 are these.

There exist a finite number of normal simple algebras over P, which can be determined and which possess the following property—*viz.*, the complete solution of $f(x)=0$ is equivalent to a solution of a "Formen-Problem" if there exists a complete Matrix algebra among the previously mentioned finite number of them. If there does not exist any such algebra among them, then the field P is to be extended. If $m$ is the smallest of the indices of the algebras over P, then the degree of the extended field P′ over P is at least equal to $m$. If $n$ is the dimension of the space in which the collineations are supposed to act, then the degree of P′ over P cannot exceed $(n+1)$. The results are illustrated by taking the quintic, sextic and septic equations.

K. V. I.

## Raman Effect of Cyclohexane.

K. HABERL [*Ann. der Phys.*, 1934, **21(5)**, 301] has found a remarkable fluorescence in the Raman spectrum of cyclohexane excited by Hg-radiation with a great temperature dependence. The regions of fluorescence are about 2,900 A. U. and 4,000 A. U. He has also found that the fluorescence disappears if the Hg-radiation is filtered through a glass plate. No explanation of the above phenomenon is yet given.

## Experiments with Positrons.

IN *Zeitschrift für Physik*, 1934, **92**, pp. 485–512, E. Rupp gives a detailed account of the experiments conducted by him with the object of discovering the properties of the positron. His results agree in the main with those of other workers, particularly J. Thibaud, but the special interest of the work lies in the way in which the positrons were produced. In their first experiments on induced Radioactivity Curie and Joliot found that when aluminium was bombarded by $\alpha$-particles it was changed to radio-phosphorus which emitted positrons. This has been utilised in the present work to obtain a source of positrons. Even the $\alpha$-particles were produced in the laboratory by bombarding lithium by highly accelerated protons. The $\alpha$-particles so produced then hit the aluminium and gave rise to positrons. A large number of experiments were conducted to determine the properties of these positrons. The value of $e/m$ for the positron was found to be $0{\cdot}95 \pm 0{\cdot}05$ times that for the electron. The positrons when scattered by aluminium and gold foils showed no diffraction rings while electrons of the same energy do show such patterns. The absorption coefficients of Al, Cu and Au, for positrons were 30 per cent. smaller than for electrons. The loss of velocity was greater for positrons than for electrons when they traversed similar foils of Al. The positrons did not dislodge secondary positrons but liberated secondary electrons as efficiently as primary electrons do. The positrons excited a strong X-radiation whose wave-length was independent of the velocity of the positrons, while electrons produce X-rays whose wave-length does depend on the velocity of the electrons. In the mean each positron produced two quanta of X-radiation. The positrons were not

found to produce artificial transmutation of elements.

T. S. S.

## The Production of Neutrons from Beryllium by means of hard X-rays and artificial Radioactivity.

In a recent communication published simultaneously in *Nature* (1934, **134,** 880) and *Die Naturwissenschaften* (1934, **22,** 839), A. Brasch, F. Lange and A. Waly of Berlin and T. E. Banks, T. A. Chalmers, L. Szilard and F. L. Hopwood of London describe experiments in which neutrons were liberated from beryllium by means of hard X-rays. The X-rays were produced by high-voltage electron tubes worked by a high-voltage impulse generator installed in the High Tension Laboratory of the A.E.G. in Berlin and capable of delivering several million volts. The X-rays produced from a tungsten anticathode in a tube working at 1·5 million volts fell on the beryllium. Bromoform was irradiated by the neutrons thus produced and when the radioactive Bromine isotope was isolated in London it was found to have an activity with a half-value period of six hours. The activity was increased when the voltage of the tube was increased to a value below two million volts. The activity showed a rapid increase with an increase in the voltage. This can be explained if there is a limiting wave-length for the X-rays which can liberate a neutron from beryllium, for the fraction of the total output of the X-ray tube, which is harder than this limiting radiation will increase rapidly with increasing voltage applied to the tube.

T. S. S.

## The Genesis of Elements.

G. N. Lewis (*Phys. Rev.*, 1934, **46,** p. 897) has put forth an interesting hypothesis regarding the genesis of elements. All celestial bodies except those having the highest temperatures are supposed to consist mainly of the elements that are found in metallic meteors (mostly Ni and Fe) which are assumed to be thermodynamically most stable states with respect to transmutations amongst elements. But they become affected superficially by the action of radiation of the type of the cosmic rays or the much harder rays as are responsible for the so-called "bursts". This results in the formation of the lighter elements as are found in the earth's crust and the stony meteors. Less often the nuclei may combine to form the heavier elements. The disintegration of the nucleus under the action of radiation mostly takes place so that (*a*) an even splitting into two nuclei takes place, each having half the mass and half the charge of the original nucleus, or (*b*) a nucleus of the type "$4n$" is formed. Sometimes such processes yield a few unknown isotopes. These are assumed to be unstable and are supposed to undergo $\beta$-ray transformations producing the more stable elements.

By this hypothesis it has been possible to account for the nature and extent of occurrence of the more abundantly occurring elements in the earth's crust and the stony meteors. This supports the favourite theory of the petrologists that the interior of the earth consists of metallic masses resembling nickel steel.

K. S. G. D.

## Platinum-Rhodium Alloys for Oxidation of Ammonia.

The catalytic oxidation of ammonia to oxides of nitrogen is from the standpoint of industry, one of the most important reactions in heterogeneous catalysis. The choice of a suitable catalyst and the conditions of economic operation have been the subject of a number of investigations. Two general types of commercial processes have been in use: (*a*) Those in which the operation is carried out at atmospheric pressure; (*b*) Those in which the reaction is conducted at high pressures. The choice of a proper catalyst is thus governed by the operating conditions. During the War, iron oxide catalyst with bismuth oxide as promotor was employed in Germany, but was subsequently given up in view of the low efficiency. Platinum in the form of fine gauze has been extensively used, but the loss of metal under the operating conditions is a factor which cannot be neglected. The optimum condition for the minimum loss of catalyst by disintegration, high conversion efficiency and large capacity under the actual conditions of commercial operation have been worked out by Handforth and Tilley (*Ind. Eng. Chem.*, 1934, **26,** 1287). They have shown that Platinum-Rhodium alloys containing 5-10% of Rhodium have been found to give a low loss of metal and

high capacity under the operating conditions required for the maintenance of high conversion efficiency. Thus at the same temperature (900°C.) the conversion efficiency of 10% Rhodium alloy is 99% while that of pure platinum is 95%. The loss in weight under similar conditions for the Platinum-Rhodium alloy is much lower than that for pure platinum. The results are of importance not only in industry, but also in the elucidation of the theory of promotor action.

M. P. V.

## Observation on Spherulites.

A COMPREHENSIVE study on spherulites has been made by R. J. Colony and A. D. Howard (*Am. Mineralogist*, Nov. 1934, **19**, No. 11) from the rocks collected from various places in America. The point of interest is the distribution of microlites both within and around the spherulites. The microlites within the spherulites are arranged in a confused manner, while around the spherulites, they are bent and show a characteristic alignment. Experimental determination with menthol and pyroxene showed, that as long as the melt remained sufficiently liquid the microlites were borne toward the growing spherulite and the arrangement was haphazard. As the viscosity increased the movement became slower, and theoretical discussion has revealed that the fibres of microlites will curve around the spherulites. He has also observed the interesting phenomena of spherulites growing within spherulites, and after discussing the various alternatives, he suggests that the larger or the host spherulite started growing first, and when it included the smaller one the latter could not grow due to lack of supply of material, while the former became bigger and bigger due to continuous growth. From the experimental evidence and theoretical discussion he has concluded that at the time of emplacement the lava was sufficiently liquid, so that the microlites were disturbed by the diffusion currents set up in response to spherulitic growth. From this study he has shown that since there is a close relationship between viscosity and the rate of cooling, the arrangement of microlites in the spherulites may be used as an indication of the comparative rates of cooling of similar lavas.

## Magmatic Wedge.

AFTER contributing a series of important papers on crustal mechanics J. S. DeLury has published a very interesting article (*Am. Journal of Science*, Nov. 1934, **28**, No. 167) on 'the magmatic wedge'. In this he has made a detailed study of the geothermal gradients and their relation to the development of magma in sub-crustal regions. In this connection he suggests that magmas are locally formed and locally intruded in contrast to huge vertical magma chambers. From the geophysical data available he has discussed the principle of hydraulic wedge and migration of magma with reference to solid flow. His conclusions have a direct bearing on such major problems of geology as continental drift isostasy and petrogenesis. In the end he suggests that assimilation in its broadest aspect would appear to be the controlling factor in the development of diverse rock types though some aspects of differentiation cannot be ignored. This is indeed a statement, which will revoke the controversy between the two schools, namely, the assimilation and differentiation. But, however, it is gratifying to note that a further contribution on this aspect of the question is under preparation and petrologists in particular will be watching with interest the publication of the same.

## Liopelma Studies.

### No. 1. INNER EAR; No. 2. CRANIAL CHARACTERS.

D. S. WAGNER in these two papers (*Anat. Anz.*, 1934, Bd. **79**, 51–64–65–112) amply puts forth evidences in favour of the erection of the group *Liopelmidæ* by Noble to accommodate Ascaphus and Liopelma. The *Liopelmidæ* lack a middle ear, annulus tympanicus plectrum and eustachian tubes. Only the operculum persists. The quadratomaxillary is also absent. The inner ear, however, does not suffer a parallel degeneration. Liopelma is linked with Ascaphus further in possessing separate passages for V and VII nerves, and a foramen acusticum medium. Thus the study of the otico-suspensorial region of the skull of Liopelma certainly affords corroborative evidence of he autonomy of the *Liopelmidæ*.

## Science Notes.

*New Year Honours.*—The names of the following men of science are included in the list of recipients of the New Year Honours:—

*C.I.E.*, Rai Bahadur Dayaram Sahni, Director-General of Archæology. *Knighthood*, Lt.-Col. T. N. Duggan, Grant Medical College, Bombay. *Dewan Bahadur*, Rao Bahadur S. E. Ranganathan, Vice-Chancellor, Annamalai University. *Rai Bahadur*, Rai Sahib Malik Charan Das, Secretary, Imperial Council of Agricultural Research Department. *Rao Bahadur*, Mr. G. N. Rangaswami Iyengar, Millet Specialist, Agricultural Research Institute, Coimbatore.

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We are happy to felicitate Rao Bahadur L. K. Ananthakrishna Ayyar, the veteran Anthropologist of India, formerly Professor of Anthropology, University of Calcutta, on his being nominated a Fellow of the French Academy. The Minister of Education in France has also presented Mr. Ayyar with the French National "Brevet" appertaining to "Officer D'Academie".

* * *

Prof. M. W. Rosenthal has been appointed by the Mysore Durbar as Professor of Pathology, Medical College, University of Mysore, and Officer-in-charge, Sri Krishnarajendra Hospital, Mysore. His wife Dr. M. E. Rosenthal has been appointed Medical Adviser to the Women and Children Welfare Committee, Mysore.

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Prof. William Wright, Dean of the London Hospital Medical College, was on a short visit to India in connection with the preliminary examination of the Royal College of Surgeons. This was the first time the examination was conducted in India.

* * *

*Cotton Research Studentships.*—The Indian Central Cotton Committee will award in February 1935 two research studentships tenable for 2 years from April 1935. The studentships are of the value of Rs. 100 per mensem during the first year, and Rs. 120 per mensem during the second. One will be awarded in Botany (Cotton Breeding) and the other in Cotton Entomology (Cotton Pests) if suitable applications are received.

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Mr. T. L. Merriman, I.C.S., has been nominated a member of the Indian Lac Cess Committee, Imperial Council of Agricultural Research Department *vice* Mr. H. E. Horsfield resigned.

* * *

*Indian Science Congress, 1936.*—According to a report appearing in *Statesman*, Dr. Sir Upendranath Brahmachari, KT., M.D., Ph.D., F.A.S.B., has been elected President of the Indian Science Congress, 1936, which will be held at Indore in January 1936.

* * *

*Scientific Exhibition, Royal Institute of Science, Bombay.*—It is not often that one can see in India, Scientific Exhibits and devices like those displayed at the Exhibition organised by staff and students of the Royal Institute of Science, Bombay, from the 13th to 18th December, 1934, in aid of the Bombay Hospitals under the patronage of His Excellency the Governor of Bombay and Lady Brabourne. In a country where occasions like these are not a regular feature on the programme of any Institution, the layman has a special interest in them, so long as they cater for his entertainment and satisfaction of curiosities. This is much more so on account of the absence here of permanent Institutions like Science Museums of Western countries. The visitors to this Exhibition evinced a great interest in the standing exhibits as well as manipulated devices shown in all the sections, *viz.*, Physics, Chemistry, Botany and Zoology. If the number that visited is any gauge of its success, we can safely say that the Exhibition had been very popular. The amount realised to the extent of about Rs. 13,000 will go towards the relief of sufferers in Bombay Hospitals.

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*All-India Medical Conference.*—An Exhibition was organised in connection with the Conference. Sir Fazl-i-Hussain in declaring the Exhibition open, remarked "India may well be proud, that things for which, she not very long ago, entirely depended on foreign countries, can now be supplied to an increasing extent by Indian Manufactures." The need for such exhibitions is great as the medical profession needs to be informed of the progress achieved in the manufacture of chemicals, drugs, apparatus and surgical instruments by different firms within and outside India. This will not only help to further the development of the indigenous industry but will also serve to take stock of the scientific contributions to Pharmacœpia made by Indian Research.

* * *

*Advisory Board of Education.*—One of the important resolutions that was passed at the general session of the All-India Educational Conference held during the last week of December at Delhi concerns the formation of a central body whose main function will be to co-ordinate educational activities of the various provinces and which will serve as a bureau of information in all Educational matters.

* * *

*All-India Veterinary Conference.*—The Eighth Session of the Conference was held at Bombay on the 29th and 30th December 1934, Khan Sahib N. D. Dhakmarwala presiding. In the course of his Presidential Address, the Khan Sahib stressed on the need for establishing a large number of animal welfare centres. The cash value of cattle, labour and dairy products is not less than 15,000 crores of rupees annually and the need for establishing such centres distributed throughout the country is imminent. There is also need for a Central Nutrition Institute to co-ordinate research work done in the Provinces. He referred to the vast unexplored animal wealth of the country and pointed out the possibilities of improvements in dairy and farm products.

* * *

*Indian Institute for Medical Research.*—The Institute was opened at Calcutta on the New Year Day in temporary premises at 41, Dharmatola Street. In addition to a diagnostic laboratory the research department of Bacteriology and Protozoology have started work. Other departments will be started shortly when more

suitable and commodious accommodation becomes available.

A Scientific Advisory Board with several eminent scientists of India has been constituted to advise the Institute on all technical matters.

* * *

*Federation of National Educational Institutions in India.*—With a view to bring together the various National Institutions imparting higher education scattered all over India, it is proposed to form a Federation of all the Institutions. With the co-ordinated efforts, a further expansion of National Education through the medium of the language of the country would result. More than fifty lakhs of Rupees have been spent in building up all these National Institutions and several lakhs are being spent every year for their maintenance and development. At present they are more or less isolated; each University has a curriculum of its own and the degrees conferred by one is not recognised by the others. A federation which would act as an inter-University organisation and bureau of information is now needed to further the cause of National Education in India. The draft constitution and rules of procedure have been circulated among all the Institutions and a preliminary conference for constituting the federation will be held in February next.

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*Imperial Institute.*—Sir Harry Lindsay, K.C.I.E., C.B.E., I.C.S., has been appointed Director of the Imperial Institute, London, with effect from 1st October 1934 *vice* Lieut.-Gen. Sir William Furse, K.C.B., D.S.O., retired.

Sir Harry Lindsay was Director-General of Commercial Intelligence, Calcutta, 1916-21 and Secretary to the Government of India, Commerce Department in 1922. He was appointed Government of India Trade Commissioner in London in 1923.

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*Awards of the Royal Society, 1934.*—The *Copley Medal* was awarded to Prof. T. S. Haldane in recognition of his discoveries in human physiology and of their application to Medicine, Mining, Diving and Engineering. (2) The *Rumford Medal* was awarded to Prof. W. J. de Haas for his researches on the properties of bodies at low temperatures and in particular for his recent work on cooling by the use of adiabatic demagnetization. (3) *Royal Medals* to Professor S. Chapman for his researches on the Kinetic Theory of Gases, in terrestrial magnetism and in the phenomena of the upper atmosphere and to Prof. E. D. Adrian for his work on the Physiology of Nerves and its application to the problems of sensation. (4) The *Davy Medal* to Prof. W. N. Hawworth for his researches on the molecular structure of carbohydrates. (5) The *Darwin Medal* to Prof. A. C. Seward in recognition of his work as a paleobotanist. (6) The *Sylvestar Medal* to Earl Russell for his distinguished work on the foundation of Mathematics. (7) The *Hughes Medal* to Prof. K. M. G. Siegbahn in recognition of his work as a physicist and technician on long wave X-rays.

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*School for Polar Research, Cambridge.*—According to a note appearing in a recent issue of "Science", a centre for Polar Research was opened by Stanley Baldwin on November 16, in the presence of several Arctic Explorers. This centre is designed as a memorial to Captain Robert Falcon Scott and the facilities of the building include a library, map room, museum and archives containing all available log books, diaries and weather records kept by Polar expeditions. "Arctic and Antarctic exploration is a prolonged war which needs strategy and carefully laid plans for its successful prosecution. The new building provides a venture in study and research for all those going out into the partly known and unknown."

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The Nobel Prize for Chemistry has been awarded to Dr. Harold C. Urey, Professor of Chemistry at Columbia University, for his discovery of deuterium.

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In view of the large growth of the Indian Sugar Industry, large quantities of molasses are now available; last year the quantity produced amounted to 500,000 tons. It is estimated that this year it will amount to 650,000 tons, which the United Kingdom and a British Company has already undertaken to purchase with a view to turn them into manure. The Calcutta Port authorities as well as the railways have consented to give special rates for the export of molasses, which will prove a great boon to the sugar industry, utilising, as it does, a hitherto wasted byproduct. (*Chemical Age.*)

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*On Forecasting Weather over North-East Baluchistan during the Monsoon Months July and August.*—By A. K. Roy and R. C. Bhattacharya (Indian Meteorological Department, Scientific Notes, Vol. V, No. 58).—The difference between barometric pressures at 0700 hrs. local time at Khanpur (in the south Punjab) and Rawalpindi (in the north Punjab) is a useful factor in predicting weather over north-east Baluchistan during the two months July and August. A statistical examination of data for five years (1929-1933) confirms the belief that the days on which the pressure difference (Khanpur *minus* Rawalpindi) is negative are usually associated with disturbed weather, and the days with positive difference are generally fine. It is found that a forecast based on the single criterion would be correct on about 69 per cent. days. The results are extremely striking when the days with large negative and positive differences are taken into consideration. It is found that out of 33 days during the above period when the difference of pressure at 0800 hrs. L.M.T. on any day was 0·10″ or more, rainfall was recorded during the next twenty-four hours on as many as 29 days at one or more of the five observatories in north-east Baluchistan while measurable rain occurred only on 1 out of 54 days associated with a positive difference amounting to +0·05″ or above.

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*Mechanical Testing of Timber.*—(His Majesty's Stationery Office. Price 1s. net. Post free 1s. 1d.) Anyone desiring to determine the mechanical and physical properties of timber from tests on small clear specimens will be interested in the Report of the Committee on the Mechanical Testing of Timber. This Report is the result of a critical examination into existing standard methods of the mechanical testing of timber in the form of small specimens free from defects. The

conclusions arrived at are constructive and certain recommendations are made concerning existing practice. The report is fully illustrated with diagrams and photographs.

* * *

*The Physiological Society of India.*—A society, named "The Physiological Society of India," has been started in Calcutta in July, last year, and has been registered in December. This Society aims at promoting and organising researches in Physiological and Bio-chemical problems of India by enlisting the co-operation of Physiologists and Biochemists working in the various laboratories of India and also of those scientists and medical men who take an interest in these two basic medical sciences. The Society had already arranged four ordinary meetings in which several important contributions by research workers were discussed. The office-bearers of the Society are:—

*President.* S. C. Mahalanobis, Esq., B.Sc. (Edin.), F.R.S.E., I.E.S. (Retd.), Professor of Physiology, the University of Calcutta and Carmichael Medical College, Calcutta. *Vice-Presidents.*—(1) Sir Nilratan Sircar, Kt., M.A., M.D., D.C.L., LL.D., formerly Vice-Chancellor, Calcutta University. (2) Sir Kedarnath Das, Kt., C.I.E., M.D., F.C.O.G., Principal, Carmichael Medical College, Calcutta. (3) Sir Upendra Nath Brahmachari, Kt., M.A., M.D., Ph.D., Professor of Tropical Medicine, Carmichael Medical College, Calcutta. (4) Dr. Bidhan Chandra Roy, M.D. (Cal.), M.R.C.P. (Lond.), F.R.C.S. (Eng.), Professor of Medicine, Carmichael Medical College, Calcutta. (5) Dr. H. E. C. Wilson, Professor of Bio-Chemistry, All-India Institute of Hygiene and Public Health. *Secretaries.*—(1) N. C. Bhattacharji, Esq., M.A., B.Sc., Professor of Physiology, Presidency College, Calcutta. (2) N. M. Basu, Esq., M.Sc., Professor of Physiology, Presidency College, Calcutta. *Asst. Secretary.*—Dr. P. N. Brahmachari, M.Sc., M.B., P.R.S. *Treasurer.*—Dr. B. B. Sarkar, D.Sc. (Edin.), F.R.S.E., Professor of Physiology, University of Calcutta. The Executive Committee of the Society consists of the above office-bearers and eleven other members representing various institutions.

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*The Indian Botanical Society.*—The following resolutions were passed at the Annual Meeting of the Society held in Calcutta on the 4th January 1935:—It has come to the knowledge of the members of the Indian Botanical Society that a proposal is under consideration for the removal of certain irreplaceable Botanical specimens of great scientific value, including type-specimens, hitherto preserved in the Herbarium of the Royal Botanic Gardens, Sibpur (Calcutta). This body views the proposal with serious apprehension, realising, as it does, that the removal of any such specimens is bound to be detrimental to the progress of research in systematic Botany in India. It is strongly opposed to the removal from this country of any specimens except one out of a triplicate set (not being a type specimen) for purposes of *temporary* loan or exchange.

2. This body is further of opinion that in the interest of Botanical Research in India it is imperative for the Botanical Survey:

(*a*) To frame and enforce strict rules as is done by the authorities of Kew Herbarium, the British Museum, the Indian Geological Survey and the Indian Zoological Survey, for controlling the loan or exchange of specimens.

(*b*) To prevent all further transfers of types and co-types *under any circumstances.*

(*c*) To demand the return to India of all type-specimens belonging to the Botanical Survey previously sent abroad either on temporary or permanent loan.

3. This body understands that the question of removal originated during policies of retrenchment when dangers to historic collections in general were agitating the minds of scientists. This body places on record the opinion that considerations of economy should not be allowed to stand in the way of the preservation within the country of original specimens of scientific value, which constitute a national asset.

4. This body therefore strongly urges the Government of India to provide the necessary facilities for the adequate housing and preservation in this country of the specimens in question.

5. This body also recommends that the Government of India may be pleased to restore, if possible, the two posts retrenched from the Botanical Survey.

6. This body resolves that the above resolutions be communicated to the Government of India and to the Government of Bengal.

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*Back Numbers of the Biochemical Journal.*—Back volumes of the Biochemical Journal, Volumes 15 to 27 (1921-1933) and Index to Volumes 11-20, are available for sale. The first four volumes (1921-1924) are bound. Enquiries regarding the purchase of the same are invited. Apply to "B.J." C/o. *Current Science*, Indian Institute of Science, Hebbal P.O., Bangalore.

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We acknoweldge with thanks the receipt of the following:—

"Actualites Scientifiques et Industrialles," Nos, 159, 160, 165, 177, 180, 181, 182, 183, 185, 186, 187.

"The Journal of Agricultural Research," Vol. 49, Nos. 6 & 7.

"The Proceedings of the Association of Economic Biologists," Vol. I (1930-1933).

"The Biochemical Journal," Vol. 28, No. 5.

"The American Journal of Botany," Vol. 21, No. 9.

"The Journal of Institute of Brewing," Vol. 40, No. 12, December 1934.

"The Canadian Journal of Research," Vol. 2, No. 5.

"The Chemical Age," Nos. 804-807.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 67, No. 12.

"The Journal of Indian Chemical Society," Vol. 11, No. 11.

"The Experimental Station Records," Vol. 71.

"Forschungen and Fortschritte," Jahrgang 10, Nos. 31, 33, 34, 35 and 36.

"Indian Forest Records," Vol. 20, Nos. 12 & 14.

"Indian Trade Review," Vol. 12, Nos. 71 & 72.

"Monthly Statistics of the Production of Certain Selected Industries of India," No. 6 of 1934-35, September 1934 (Government of India Publication).

"Advance Proceedings of the Asiatic Society of Bengal," Vol. 1, No. 3.

"Bulletin of the Academy of Sciences of the United Provinces of Agra and Oudh, Allahabad, India," Vol. 3, Nos. 3 & 4.

"Proceedings of the Academy of Sciences of the United Provinces of Agra and Oudh, Allahabad India." Session 1934-35, Pt. 1, Vol. 4.

"Mathematics Student," Vol. 2, No. 3.

"Medico-Surgical Suggestion," Vol. 3, No. 11.

"Meteorological and Scientific Notes," Vol. 5, No. 8.

"Nature," Vol. 134, Nos. 2396-2398.

"Natural History," December 1934.

"The Journal of Nutrition," Vol. 8, No. 5.

"The Russian Journal, Tome IV (66), Nos. 4, 5 and 6.

"The Review of Scientific Instruments," Vol. 5, No. 11.

"The Indian Trade Journal," Vol. 115, Nos. 1487-1489.

## Reviews.

THE DRAMA OF WEATHER. By Sir Napier Shaw. (Cambridge University Press.) Price 7*s*. 6*d*.

The English-reading public owe a deep debt of gratitude to the dozen of British meteorologists and the author of the four volumes of the *Manual of Meteorology* for this eminently readable little book on Meteorology.

In a small space of 270 pages, Sir Napier has treated the sequence of events taking place in the sky and constituting weather as the progress of a great drama. The stage is the whole atmosphere, the actors in the drama are the clouds, rainbow, lightning, water spouts, dust-storms and weather phenomena. Some of the jewellery of the actresses such as the beautiful ice crystals constituting snow, come in for detailed description. The qualifications of the watchers of the play, namely, the observers, and their equipment which is the instruments of a meteorological observatory, are then attractively described. The recounting of the story of the weather by the watchers and their attempts at finding the leading motives of the author of the play are told in the next chapter. Sir Napier's great skill in compressing a vast amount of material in the form of well-chosen and original diagrams and tables is exceptionally well seen in this chapter. The periodic phenomena of the weather, the rhythm of the atmosphere, is shown by the diurnal and seasonal variations. Besides rhythms which any one can see, there are others like the variation of water-level of Victoria Nyanza with the sunspot number, which can be discerned only when expounded by a knowing critic. The last chapter puts together what different watchers of the play see, each from his own corner. The development of the modern weather-map is described beginning with an investigation by Le Verrier of the travel of a storm which destroyed the British and French fleets at Sebastopol in 1854 to the latest Norwegian mode in which the meteorologist tries to identify the different "air-masses" present on the stage, and the places and times where they come into conflict and form an estimate of the relative strengths of the fighting forces, apparent and hidden, so as to give his verdict as to what the result of the fight will be. In an epilogue, Sir Napier gives us his idea of what the weather-map of the future will be—a map in which many vertical cross-sections of the atmosphere with actual temperatures (and moisture contents) and actual winds will be available to supplement the information given by the ground-map. In a very partial way, the wish is gradually becoming realised in different parts of the world.

Finely got up and enriched with beautiful pictures the book forms a most attractive introduction to Modern Meteorology.

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EXPERIMENTAL PHYSICS—A SELECTION OF EXPERIMENTS. By G. F. C. Searle, F.R.S. (The Cambridge University Press, 1934.) Price 16*s*. net.

The name of G. F. C. Searle is a household word among University students of Physics on account of the numerous pieces of apparatus of his designing which they meet with in their Practical Work. All these instruments display great ingenuity on the part of the designer and combine simplicity with precision to a high degree. We have already a number of books by the author in which experiments of an ordinary kind are shown to be capable of great variety. In the book before us a few experiments of an advanced character are selected from each of the following subjects, *viz.*,

Dynamics, Elasticity, Surface Tension, Viscosity, Heat and Sound, and described in detail with full discussions of the theory, the details of the design and the method of procedure. A very valuable part of each description is the numerical record of a specimen experiment with individual readings and calculation of results and errors set out so as to serve as a model to the student. Although the experiments described are not of a routine character, Honours students may profitably replace some of the stereotyped ones by those given in this book. The theoretical discussions are also original and a perusal of the book will give the student a good insight into the correct method of going about his practical work. Apart from the detailed descriptions of some ingenious experiments, the teacher will find that the book sharpens his own ingenuity towards designing new experiments to suit the conditions of his class: the author of the book is an admirable model to follow in this respect. We heartily recommend the book to the serious attention of all Honours students and teachers of experimental Physics.

T. S. S.

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CRYSTALS AND THE POLARISING MICROSCOPE. By N. H. Hartshorne and A. Stuart. (Edward Arnold & Co.) Price 16*s*. net.

The Polarising Microscope is of general aid in the examination of all kinds of solid material preparatory to its analysis, since examination with it may often indicate whether the material is homogeneous or heterogeneous, and may even suggest the best lines of carrying out the analysis. It has long been of use to the petrologist and the crystallographer and in recent years organic and inorganic chemists are also beginning to realise the value of the polarising microscope. This concisely written treatise would be of great help primarily to chemists and to other users of the polarising microscope who have at present little choice between elementary books intended for the junior student of geology and advanced treatises. The morphology and the optical properties of crystals are treated in a concise manner in the earlier chapters, and the method of using the polarising microscope both with parallel and with convergent light is treated in detail in the later chapters. A full chapter is devoted to the description and construction of the polarising microscope. Full details of the methods of examination of crystals for the determination of their size, thickness, refractive index, isotropism or anisotropism, pleochroism, etc., are given, and it is hoped that these chapters will be of use to students of physics as well. Examples are given of the uses of the polarising microscope in chemical practice. The get-up of the book is very nice and the language and presentation are agreeable. The fact that the price of the book is somewhat high at sixteen shillings is compensated by its value to all users of the Polarising Microscope whether they are physicists, chemists or geologists.

S. R.

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LABORATORY MANUAL OF COLLOID CHEMISTRY. By Harry N. Holmes. Third Edition, Rewritten and reset. Pp. xvii+229, 1934. Price 20*s*. (John Wiley & Sons, Inc., New York.)

Since its first appearance in 1922 the *Laboratory Manual* has held an esteemed place in the library of all colloid chemists, and the present edition which has been considerably improved and enlarged to include recent developments will be welcomed by all. Chapters on "catalysis and colloid chemistry" and "non-aqueous colloidal systems" have been added and many of the chapters particularly those on "adsorption," "surface and interfacial tension" have been enlarged and much useful matter added, the format of the volume remaining more or less the same.

We have gone through the volume with much profit and can offer nothing but praise for a volume containing such wealth of material so systematically arranged and so clearly presented. The author rightly points out in the preface that "when an unusual technic in the colloid realm is needed, it is believed that this manual will serve well as a reference guide." The get-up of the volume is excellent, and the binding is of the "vermin proof" type. The price of the book embodying so many useful features, appears to be quite reasonable, and we have no doubt that this book will find a place as a laboratory companion to all colloid chemists.

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INTRODUCTORY COLLOID CHEMISTRY. By Harry N. Holmes. xiv+198 pp. (John Wiley & Sons, Inc. New York.) Price 15*s*. 6*d*. net.

The book serves as a useful introductory text to the author's *Laboratory Manual of Colloid Chemistry* the third edition of

which has appeared along with this volume. The arrangement of the chapters follows closely that in the author's *Manual* and in several places even the wordings in the two volumes are similar. References to original literature are given for the benefit of the student. The author's intention to provide for the use of chemists, a "handy volume" on their desks, "to which they can turn for quick reference" has resulted in the publication of a useful introductory volume, which satisfies the demand for a brief general survey of the fundamentals of Colloid Chemistry.

* * *

CONDUCTOMETRIC ANALYSIS, Principles, Technique and Applications. By Hubert T. S. Britton. Pp. xi+178, 1934. Price 12/6. (Chapman and Hall, Ltd., London.)

The last few years have witnessed a growing interest in the application of conductometric principles to chemical analyses, and the large amount of literature that has accumulated, has necessitated the writing of a monograph on conductometric analysis. We have had occasion to review a few of the monographs published by Messrs. Chapman and Hall under the Editorship of Dr. Howard Tripp, and the present volume which is the eighth in the series is admirably got up, and comes up to the ideals which the Editor has set himself in designing these publications.

Electrometric methods particularly those concerning the measurement of pH have been extensively employed in chemical analyses essential to the control of industrial processes, and in research. The aid of conductometric methods, which admit, perhaps, of a more extensive application, have been invoked by the physical chemists, only during the past few years, and these have already yielded very valuable data, and in a few instances, such as in the accurate estimations of very weak acids and bases, and the determination of the components of mixed acids, have proved invaluable. A large field concerning their application to industrial processes awaits investigation and as they can be applied to different types of solutions—coloured, opaque, colloidal, etc. and can be employed for the estimation of neutral salts in solutions, they possess advantages not obtained in potentiometric methods.

The book is a very handy volume comprising much useful information. The author has stressed the importance of the principles underlying conductometric analyses, a thorough grasp of which will be found of great utility in developing and extending this branch of analytical chemistry. Copious references are cited to original literature which will be found invaluable to the research student. One would have wished that all the citations were given at the foot of the page as this would facilitate collateral reading. There are one or two minor misprints such as 2·33 for 2·23 on page 32, last line in the table of values of $\frac{100-x}{x}$, column 4, and O.2N NaOH for O.2N HCl in line 3, page 140. A more comprehensive subject index too would have proved useful. The book fulfils a real need for a comprehensive account of the recent advances in conductometric analysis, and we have no doubt that it will be welcomed by all chemists.

* * *

INTRODUCTION TO PHYSIOLOGICAL CHEMISTRY. Third Edition. Re-written and re-set. By Meyer Bodansky, pp. xi+661. (Messrs. John Wiley & Sons, 1934.) Price 25*s*.

The fact that the book has run through the third edition and is the tenth impression since 1927 stands out as a testimony to its great popularity. It is a well-known fact that the large output of research work in all branches of Biochemistry, renders text-books rapidly out-of-date and calls for revised and enlarged editions. While several monographs are appearing in various aspects of the subject, a text-book incorporating, in an eminently readable manner, the latest advances without losing the historical perspective, and yet condensed into a reasonable handy volume, fulfils a real want. Prof. Bodansky has set himself a greater task—that of providing to the student who needs more detailed information on specific subjects, references to literature,—journals, monographs, reviews, etc.,—and has brought out a work whose scope is more than that of a mere text-book. All these features contribute to the extreme popularity of this text-book.

The present edition incorporates several improvements. The references which have been brought up-to-date are cited as footnotes and this will be welcomed by those who frequently resort to collateral reading. Several chapters have been re-written and those on enzymes, harmones, vitamins, etc., have been enlarged and made more

exhaustive, so as to incorporate the more recent advances.

The book is singularly free from printers' errors and should find a top place in the library of all physiological chemists.

* * *

IRWIN CANAL SOIL SURVEY REPORT, SERIES I.—Introductory and General Part. By B. Narasimha Iyengar, B.A., Ph.D. Pp. 18+4 maps. (Printed at the Government Press, Bangalore, 1934.)

The above publication refers to the survey of a large area of land which will soon be brought under irrigation by the Irwin Canal in Mysore State. A third of the area may come under a monsoon crop like paddy requiring continuous supply of water, another third under dry crops requiring occasional supply of water and a further third under others requiring intermittent irrigation throughout the year.

The soil types are similar to those encountered in many parts of the Deccan plateau. The texture of surface soils (the first six inches) varies from stony to sandy and loamy in the pale yellow to light red groups, from loamy to sticky in the light red to deep red groups and from loamy to clayey in the grey soil group. The stickiness in red soil does not seem to be due to clay but to a large amount of colloidal iron oxide. Chemical analyses show that the soils are generally poor in regard to the essential mineral nutrients. Nitrogen content varies from 0·0062 to 0·099 per cent., but most soils contain only between 0·02 and 0·04 per cent. Total phosphoric acid is generally low and the availability, as determined by citric solubility, still less, ranging between 0·0002 and 0·021 per cent. All the soils would thus appear to be deficient in regard to available phosphorus. Potash content varies from 0·0085 to 0·077 per cent. and lime between 0·02 to 1·1 per cent. The reaction is mostly about neutral, the pH ranging from 6·5 to 7·5. Although the alkali content of the surface is generally less than 0·2 per cent., it is yet probable that with the altered conditions introduced by irrigation, the concentration may increase in some of the localities. Further research on this aspect is needed.

The latter part of the survey relates to a discussion of the lines along which the area should be developed in the future. Among the suggestions made by the author may be mentioned: (1) rapid extension of cane cultivation; (2) introduction of short season money crops; (3) creation of facilities for the cultivation of cocoanut, plantains and mulberry; (4) formulation of a drainage scheme in areas where alkali may tend to accumulate; (5) measures to preserve the cattle and sheep rearing industry of the tract; and (6) creating facilities for co-operative marketing of crops.

The author deserves much credit for the immense amount of work that had to be organised both in the laboratory and on the field. It may, nevertheless, be pointed out that some of the analytical data that would have thrown much valuable light on the nature and general fertility of the soils concerned are still wanting. There is no mention of any determination of the mechanical composition of the soils or their organic matter contents. Attention may also be drawn to the inadequacy of the citric solubility method when determining the availability of phosphorus in soils which are naturally rich in iron.

* * *

BREEDING AND IMPROVEMENT OF FARM ANIMALS. By Rice.

Professor Rice has to be congratulated for getting up such a well-planned book on Animal Husbandry. It is lucidly written, well illustrated and the book itself is attractive.

The two chapters on the reproductive organs are a valuable addition to a book like this on Animal Husbandry. The author not only deals with all the aspects of the science of inheritance but explains the methods of breeding adopted in the breeding of animals. The chapters on fertility and sterility are interesting, but the Indian student should bear in mind that some of the facts such as age at first breeding and season for breeding are not wholly applicable to Indian conditions. From the scientific side of inheritance the Johnson theory of pure line has not been elaborated probably because it can be got from books like *Genetics in relation to Agriculture* by Balcock and Clausen and others. While he has brought up to date most of the work on sex determination, due weight has not been given to authentic cases of sex reversal in poultry.

The chapters describing the methods of breeding and grading, cross-breeding, inbreeding and selection will be very useful to both the teacher and the student of Animal Husbandry. The chapters on development and

fitting for sale and selling are useful to the student. It is surprising that more detailed information is not given with regard to artificial insemination on which a great deal of work is being done in Russia and some useful work is being done both at Edinburgh and Cambridge. The chapter on breed analysis and the four appendices, (*a*) Biometry, (*b*) Inheritance of Farm Animals, (*c*) Livestock Rural Association, and (*d*) Supplementary references will be useful to the research worker. Inheritance in farm animals is by no means complete nor do they all apply to Indian stock. The remarkable omission is the work by Buchanan Smith and his co-worker on the inheritance of milk in cattle. In the Jersey they have noticed indication of sex linkage for milk production—a very useful finding for the dairy cattle breeder.

This book will be found very useful to the teacher and student of Animal Husbandry and it should find a place in every Agricultural College Library.

## Acknowledgment.

WE have pleasure in tendering our warmest thanks to the authorities of the Andhra University for their generous grant of Rupees *One Hundred* for the year 1934–35. It is gratifying to note that the Universities which foster and promote learning are appreciating the services of *Current Science*, thereby encouraging us to proceed forward in a spirit of progress and service.

We also take this opportunity to record our deep sense of gratitude to the Executive Council of the Nagpur University for renewing the annual grant of Rupees One Hundred for the year 1934–35.

## Forthcoming Events.

### LUCKNOW UNIVERSITY, FACULTY OF SCIENCE.

*Special Lectures, Session 1934-35.*

Feb. 5, 6, 7, at 6-30 p.m. Biology Theatre.
"The Distribution of a Simple Epidemic Disease." By Mr. J. A. Strang, Professor of Mathematics.

Feb. 9, 10, 11, 12, at 6-30 p.m. Biology Theatre.
"The Theory and Construction of Non-differentiable Functions." By Dr. A. N. Singh, Lecturer in Mathematics.

Feb. 13, 14, 15, at 6 p.m. Chemistry Theatre.
"Internal Secretions." By Dr. S. H. Zaheer, Reader in Chemistry.

Feb. 16, 18, 19, at 6 p.m. Chemistry Theatre.
"Artificial Colouring Matters." By Dr. S. M. Sane, Reader in Organic Chemistry.

Feb. 23, 24, 25, at 6-30 p.m. Chemistry Theatre.
"The Orientation of Molecules and Surface Reactivity" (Illustrated). By Dr. A. C. Chatterji, Lecturer in Chemistry.

Feb. 26, 27, 28, at 6-30 p.m. Biology Theatre.
"Parasitic Worms and Disease" (Illustrated). By Dr. G. S. Thapar, Reader in Zoology.

### ELECTRICAL ENGINEERING SOCIETY, BANGALORE.

(*The lectures will be delivered at the Indian Institute of Science at 3-0 p.m.*)

Jan. 30th. "Frequency Multipliers." By Mr. N. R. Junnarkar, B.E.

Feb. 6th. "New Statistics." By Mr. M. K. Gopaliengar, B.Sc.

Feb. 13th. "An Automatic Rotary Sub-Station." By Mr. S. P. Divgi, B.Sc.

Feb. 20th. "Evolution of Electric Lamps and Illumination." By Mr. G. C. Kanitkar, B.E.

Feb. 27th. "Recent Advances in Carrier Current Art." By Mr. S. P. Chakravarti, M.Sc., D.I.C.

1-35.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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CONTENTS.





# Our City Streets.

FEW will doubt the fact that the average man in the present age enjoys greater comforts and a distinctly higher standard of life than his predecessors in the past. Generally speaking, science has made it abundantly possible to prolong human life which is now less subject to disease, and its discoveries have been used to place amusements and light instruction practically within the reach of all. Transport has now become rapid and fairly safe, and the increasing appreciation of such amenities by the public supports huge industries, which provide employment both for skilled and unskilled labour. But it is equally manifest that the mechanical inventions which have rendered all these things possible have also introduced certain grave and objectionable features into our lives. It must be remembered that every material device, which distinguishes the present age from the last, is invariably noisy and sometimes even fraught with danger to the public when incautiously handled.

The streets and roads in Indian cities are becoming noisier every year, but there is still no general complaint that the noises have begun to affect human nerves and health. In India the street noises are comparatively a milder nuisance, but the danger to public health, produced by the insanitary conditions of the streets and the dust raised by the fast-moving vehicles, is always grave, and is not mitigated though most of the principal thoroughfares are asphalted. Indian towns and cities which were built in ancient times satisfy neither the principles of modern town planning nor the hygienic requirements of efficient and healthful urban life. The chief concern of the early builders was obviously to ensure protection for the towns against the aggressions of invaders, and with this object the houses were built contiguously and the roads were purposely made narrow and tortuous. In the early centuries when public life in India was frequently disturbed by the conflicts of rival parvenu chieftains, the mortal anxiety of the people was to protect their person and property in thick mud houses with small doors and smaller windows, and all built as near to each other as possible. Whether this mode of defence secured immunity from the raids of lawless criminals and free-booters might be doubted, but it is certain

that these types of buildings which effectually shut out air and light, laid the foundation of recurring epidemic diseases. The establishment of peace and security in the country under the British Rule has stimulated the expansion of trade and favoured the rapid multiplication of population, but till recently it has not affected the physical structure of towns and cities. The European community, which lived beyond the city limits from the time of Company Administration, could hardly visualise the unsatisfactory conditions under which the native population flourished, and even to-day the administrators of the country have only a vague apprehension of the squalor and maladies which afflict the extremely insanitary and congested quarters in the heart of towns. The intention underlying the transfer of municipal administration to local self-governing bodies is certainly entitled to praise, but the successful accomplishment of the task confronting the municipal commissions demanded knowledge, training, experience, imagination and financial resources which the councillors did not possess. In spite of such inadequate equipment, Indian municipalities have done a great deal towards improving the conditions of areas in their jurisdiction, but if more has not been done it is not their fault. The civic population has to co-operate and appreciate the efforts of municipalities in securing the amenities which make life enjoyable.

The introduction of motor cars, buses, lorries and trams into Indian cities without previously replanning them to receive these fast-moving vehicles, must naturally be attended by danger to public safety. This danger is two-fold. Modern traffic in the cities and towns has created a new environment to which the Indian population was not accustomed, and adaptation to it must be a question of time and long usage. The users of these new types of powerful automobiles only see in them machines made to give them comfort and speed, and hardly realise the potential damage they are capable of inflicting on the unwary public. Accidents under such conditions are bound to occur. Till the use of motors became general, the dust problem of large cities and towns used to assume menacing proportions only periodically just about the months when heavy winds continually swept over them, bringing in their train all manner of diseases. The recent preparation of certain roads for motor traffic has not, however, abated the acuteness of the problem, but on the other hand, the trouble has become more or less chronic. The tarred roads are always covered by a thin or thick layer of dust according to weather conditions; and the droppings of stray animals and the human defilement of streets and roads constitute a source of perpetual danger to public health. The unfortunate pedestrians are practically compelled to inhale the air heavily charged with them when disturbed by the passing cars, buses and trucks. What with the congestion in the towns and a continuous shower of unhealthy dust raised throughout the day, it is no wonder that the public health of large cities and towns is unsatisfactory all the year round. If every citizen will only take the minimum trouble, he has the means of protecting himself and his family from the dangers arising from dust on the one hand and from accidents on the other.

Almost every Hindu household in India used to observe till recently the custom, amounting almost to a religious practice, of washing with water the section of the road immediately in front of the principal door, both in the morning and in the evening, and to decorate the washed portion with elaborate decorative patterns with rice flour or quartz powder. The practice at one time was so general that even traders and merchants used to sprinkle the roads in front of their shops with water. This simple practice which was universal had the desired effect of mitigating the dust nuisance and cooling the air, but it has now almost disappeared. If it could be revived and the washing of the street could, with charity, be extended to the limits of the neighbouring houses, real public service of immense hygienic value would be rendered by every household, and the sanitation of the whole town would thus easily be secured, at least in part. The habit of throwing into the open streets offal and other rubbish, and the commission of nuisance in the close proximity of residential places at night and sometimes during the daytime as well, have developed recently to a tormenting pitch, and this is almost entirely due to the fact that the sense of decency and a correct knowledge of the harm done to public health by such acts do not form part of the mental equipment of the average citizen. People have to realise that these acts are deadly sins whose effects are visited on the residents of the whole street, and, that food thrown into

the drains supports the unwanted population of stray animals which contaminate the surroundings, besides being a nuisance in other ways. A street reeking with evil smell and full of fermenting heaps of rubbish must necessarily make life intolerable, and ultimately destroy æsthetic sense. Disposal of city refuse must, at all times, be a big problem for municipalities, but if every house sets apart a place where it is burned every day the hygienic condition of the street is easily and automatically secured. This must eventually lead to the diminution of the numbers of stray animals, and if simultaneously the beggar problem is solved by the combined efforts of the Municipalities and Government the dust on the city streets will undoubtedly become less offensive and dangerous. It is a duty which every citizen owes to himself and to the community at large to keep his premises absolutely sanitary, and it is almost fatal to suppose that it is his privilege to defile the streets and that it is the work of the municipality to tidy things for him. Every sanitary offence committed is an offence against humanity.

Schools and colleges have to develop this municipal sense in the minds of the younger generation. Large factories and business organisations which employ numerous workmen should insist on the strict observance of sanitary rules by the mill hands. The police constables on traffic duty and others whether in uniform or mufti should be warned to keep an eye on likely offenders, and the health officers of municipal corporations should be extremely vigilant in the exercise of the powers vested in them to prosecute people misconducting themselves from the viewpoint of decency and public health. But every one of these preventive and punishable measures can be evaded by the people if they choose, and if they are not deeply convinced that the health and the well-being of the town are their own making. If by a determined effort every householder in the town were to take measures calculated to keep his premises clean and wholesome, then he has a right to ask for protection against the noise and accidents due to reckless and negligent motor traction.

It is true that the volume of motor traffic in Indian cities has not assumed alarming proportions, but already the noise from this source is as acutely disturbing to the nerves as its speed is causing anxiety for public safety. Noise is to a large extent a subjective phenomenon, and reaction to it must be temperamental. Responsible medical opinion is agreed that, in general, noise is bound to produce serious effects, especially in the case of mental workers, young children, the nervous, the fatigued and the sick. The investigations of the Industrial Health Research Board in Britain have obtained conclusive results in regard to the effect of noise on industrial output. We cannot accept the statement usually made that the human system may become so accustomed to noise that we may cease to regard it as a nuisance. Noise is always distracting and may even become nerve-racking. It is a real menace to the efficiency of labour in every field, and the public is entitled to demand protection. In Indian towns and cities the road noises are bound to become troublesome in view of the peculiar type of structural material employed in the building of houses which are generally continuous. To judge by the evidence obtained by the National Physical Laboratory, the structure-borne disturbances travel to the buildings from the source for great distances, manifesting themselves on meeting resonant walls and rooms. Indian homes built on the old style, by their position with regard to each other in the same row and to those on the opposite, seem to be exquisitely adapted to receive every kind of noise and transmit it to the contiguous and opposite structures. Street noise has always been one of the minor horrors of Indian life, which, through ages of its insidious influence, has slowly undermined the physical and mental efficiency of the general public; and the problem assumes a grave aspect in view of the aggravating causes introduced by motor traffic.

The statistics of mortalities, published periodically by the Ministry of Transport, due to motor accidents even in European cities which have been replanned for this new mode of locomotion, and where generally people are alive to the dangers of indolence on the roads, must cause grave anxiety; and in the streets of Indian towns which are narrow and full of ruts and pot holes, and in which people move both slowly and incautiously, automobiles are capable of inflicting greater damage. The causes which are capable of producing accidents in India are far more numerous than in any country in Europe or America. The streets teem with a variety of stray animals which sometimes effectually barricade the road, and some of them have an inveterate habit of going off to

sleep right in the centre of thoroughfares. On account of the extremely congested quarters, children make use of the streets as their playground, and they generally become reckless to traffic conditions in their enthusiasm to pursue their games. School boys and college students ride their bicycles four or five abreast or walk in large bunches absorbed in discussing metaphysical problems, and totally oblivious of the traffic dangers through which they are passing. Vendors, hawkers and beggars, generally blind and defective in other respects also, are always in evidence tending to augment the general confusion. People from the villages, ignorant of traffic rules and intent more on admiring the interesting sights of cities which they visit occasionally, than on protecting their persons, are a grave menace to motor traffic. The vehicles drawn by animals such as bullocks and horses which ply on the narrow streets, are another cause of frequent accidents. In the larger cities like Calcutta, Bombay and Madras traffic has gradually come under the control of the police, but in the towns the offending public is prone to discuss matters with the traffic directors.

Motorists are not saints. The greatest danger to pedestrian traffic arises from nervous drivers and young people in charge of the wheel. The nervous motorist is always caught between two minds as much as the confused pedestrian in a critical situation, and the youthful drivers do not recognise the fact that spare parts of the human body are not procurable. The number of motor vehicles on the Indian streets and roads has not yet reached saturation point, but nevertheless the annual increase of cars, buses and trucks must directly aggravate the menace to public safety and well-being, unless steps are taken to protect the people.

It seems to us that the Road problems both in their magnitude and importance are sufficiently complex and serious to warrant the creation of a Ministry of Transport in each Province to deal with every aspect of traffic. These problems are at once scientific and psychological. The existing practice of dealing with them partly through the police department and partly through the municipalities must be empirical. This new Ministry of Transport must be attached to the Noise Abatement Commission and Industrial Health Research Board, staffed by physicists, psychologists, physicians, lawyers and engineers. It may be said that proposals of this nature are premature, because in Indian cities the problem is not so serious as in London, New York, Paris and Berlin, but the level of noise and accidents is bound to rise year by year, and wise statesmanship should not wait till the torment becomes ungovernable.

The efforts of Government alone will not be adequate to grapple with the road problems, and the co-operation of the people is indipensable for their satisfactory solution. Every town should have a People's Health League for securing protection of the public against noise, dust and accidents. The league when established might find it advantageous to work in collaboration with the educational institutions. It is the younger generation who stand in most need of imbibing the principles of public health and cultivating road courtesy and a cheerful adherence to law. It ought to be the imperative duty of Scout and Rover corps to utilise every opportunity of assisting the deformed beggars and unsophisticated village folk whenever, either out of ignorance or incapacity, they trespass the rules of traffic. Every member of the Health League and all the Scouts and Rovers should be invested with power by Government to bring to justice offenders of traffic regulations and public decency. A clean and wholesome street implies sweet and hygienic homes and both are an insurance against epidemic diseases. The task of fighting them is largely in the hands of the people themselves.

## "Physica."

THE new Dutch Scientific Journal *Physica* has entered upon its second year and we have received the first number of the second volume of this valuable publication. It was started with the object of giving greater publicity to the work of Dutch physicists and the articles are published in English, French or German. The Board of Editors consists of such well-known physicists as P. Zeeman, D. Coster, W. J. de Haas, W. H. Keesom, L. S. Ornstein and H. A. Kramers. As is to be expected from such a list of names,

the articles appearing in the Journal are of great importance and interest. Particular interest attaches to the results obtained in the cryogenic laboratory in Leyden, the measurements of intensities of spectral lines initiated by Ornstein and the X-ray studies of D. Coster and his pupils. In the issue before us we have accounts of X-ray studies from D. Coster's laboratory and of low temperature research carried out at Leyden. The Utrecht School is also represented. J. P. Schouten has an interesting note on a theorem in the operational calculus. We may confidently say that the high standard reached will be kept up in succeeding numbers. We wish the Journal a long and useful life.

## Frost Hazard in India.

By L. A. Ramdas, M.A., Ph.D.,
*Meteorological Office, Poona.*

THE farmer knows how dependent his crops are on weather conditions. A good yield is dependent, amongst several factors, upon a sufficient quantity of rain, suitably distributed, during the growing season, as well as upon a favourable sequence of air temperature, humidity, soil temperature, etc. Experience tells us that there are optimum values for these factors and that excessive rain or drought, intensely hot or cold waves, extremes of humidity or dryness, are all equally dangerous to a growing crop. In the present note we shall confine our attention to the adverse effects* of cold waves in India and the frosts which occur during their incidence.

It may be pointed out that the phenomenon of frost is essentially a radiation† phenomenon during clear nights and occurs about the epoch of minimum temperature. In lower latitudes like ours the soil is usually warmer than the air layer above it so that the latter has to cool by radiation to the colder air masses in the upper atmosphere. If there is air movement at night the stratification due to radiative cooling is upset with the result that the air temperature will not fall as rapidly as when the air is stationary. During winter at most places the mean air temperature at sunset is too high for nocturnal cooling even during favourable nights to cause frost on the next morning. This is, however, possible on days when the temperature at sunset is sufficiently low, *e.g.*, when the country is invaded by a cold wave from the north.

The northern parts of India are visited by cold waves during winter. The cold waves usually come in the wake of the western depressions which enter India, at intervals of about a week across the north-west frontier and Baluchistan and move eastwards through the Indo-Gangetic plain towards the north-east frontier of India. The origin and structure of the winter depressions have been the subjects of many investigations, notable contributions having been made by Hemraj,[1] Walker and Kameswara Rao,[2] and recently by Banerji.[3] It is now an established fact that the winter depressions which invade India are associated with the family of depressions which originate at the partition in the Atlantic regions between the warm and moist equatorial air and the cold air of the higher latitudes.

The approach of a winter depression is heralded in North India by the appearance of high clouds, and the rise of air temperature associated with air movement from the south. Later, the clouds lower and drizzling weather ensues. So long as a place lies in this "warm" sector of a depression there is no likelihood of a conspicuous fall in temperature. The passage of the "warm" sector eastwards is followed, however, by the "cold wave" during which northerly

* For two interesting accounts of the damage to crops during frost please see Bulletin No. 165 of 1930 by K. V. Joshi, Department of Agriculture, Bombay, and an article on "The Effect of Frost on some crops at Pusa" by R. D. Bose, *Agriculture and Live-stock in India*, 1933, **3**, 555.

† The loss of heat by radiation experienced by a layer of air during the night depends upon the amount and distribution of water vapour in the atmosphere. This problem is being discussed in a forthcoming paper.

1 *Indian Meteorological Memoirs*, **21**, Part 7.

2 *Ibid.*, **24**, Part 2.

3 *Meteorology of the Persian Gulf and Mekran*, by B. N. Banerji; special brochure published by the Indian Meteorological Department.

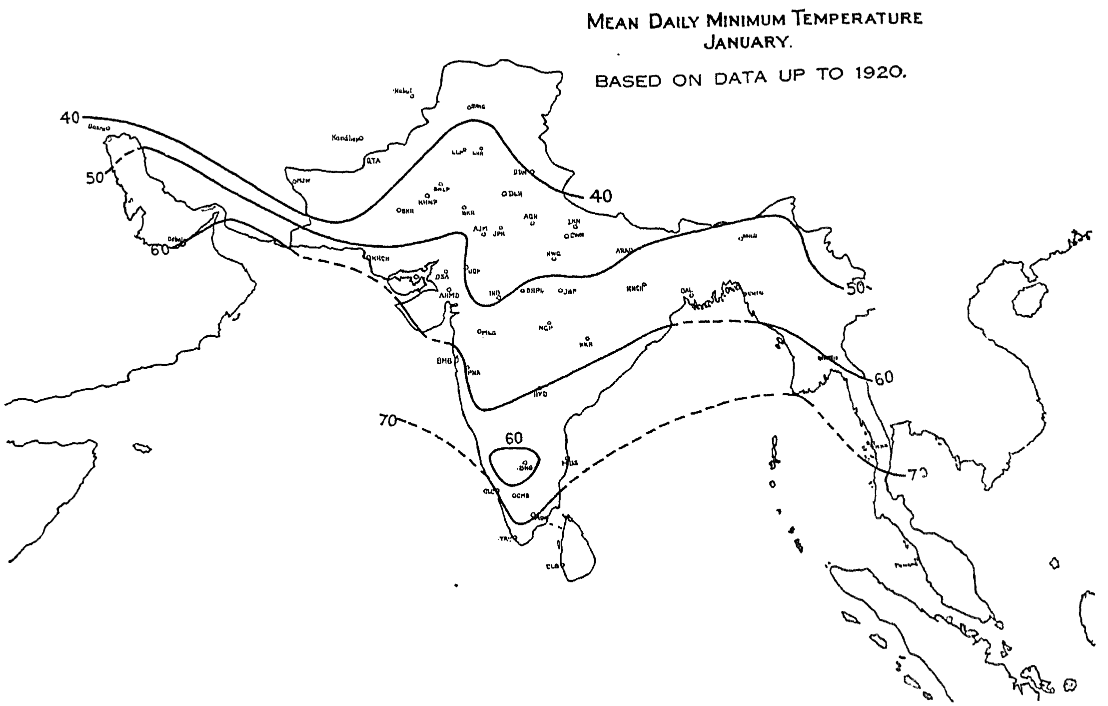


**Fig. 1.**

cold winds pour into the country. The cold wave in its turn extends or moves eastwards across the country, weakening in the meantime. As soon as another western depression approaches the north-west frontier the temperature begins to rise rapidly.

The intensity of a cold wave as well as the extent of the country which it affects depend upon a number of factors, *e.g.*, the intensity and area of the depression with which it is associated. Sometimes, the anti-cyclone over Tibet and Mongolia which is the main reservoir of cold air for Asia is itself shifted westwards towards Europe, and if at the same time a deep western depression passes through Persia and North-West India, a very severe cold wave sets in behind the depression. The phenomenal cold wave which visited India during the period 30–1–1929 to 3–2–1929 was of this type.

In most years the cold waves affect only north-west India and the adjoining parts of Sind, Rajputana, the United Provinces, Central India and Gujarat. During unusually intense cold waves even the Bombay Deccan is affected. The area to the south of latitude 18° N. is practically free from the adverse effects of the cold waves even on such occasions.

Fig. 1 shows the normal‡ daily minimum temperature over India during the month of January as recorded inside the standard screen or shed. The normal shade minimum temperature is 40° F. and above, practically over the whole of India excepting the mountainous tracts to the north.

Fig. 2 shows the lowest minimum temperature in the shade recorded up to 1920. This chart indicates that in the region lying to the north of latitude 18° N. the minimum temperatures may sometimes fall by 20° F. below the normal for January whereas to the south of this latitude the lowest minimum temperatures are only about 10° F. below the normal.

It must be remembered, however, that the temperature recorded by a minimum thermometer inside a screen at 4 ft. will be higher than the temperature recorded by a similar instrument exposed to the sky and

‡ Based on data up to 1920.

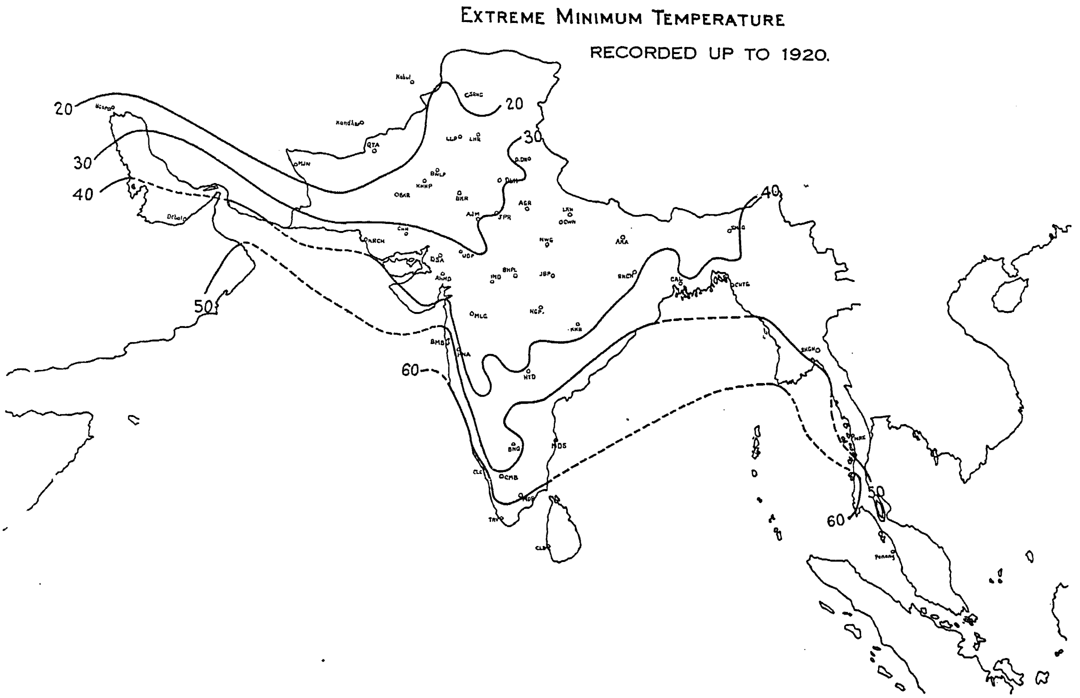


**Fig. 2.**

the ground surface. In studies on frost, we are concerned with the temperature attained during the night by objects near the ground which are exposed to the sky but which are thermally insulated from the soil. Such bodies usually radiate out more heat energy than they receive from the sky or the ground or by contact with the surrounding air.

A measure of the lowering of the minimum temperature in the open near the soil surface below the minimum temperature inside the screen at 4 ft. can be had from the nocturnal radiation temperature measurements made at a few selected stations in India for a few years. Table I gives the depression of monthly mean nocturnal radiation (minimum) temperatures below the mean minimum shade temperatures for the month of January.

On an average the depression is of the order of 10° F. in the month of January. Using similar data for other months Mr. Ananthapadmanabha Rao has prepared charts of India showing the frequency of occasions when the minimum temperature in the open fell below certain limiting values (*viz.*, below 34° F., 32° F., 30° F., 28° F.) during the period 1920 to 1929. Fig. 3 shows the total number of occasions during this period when the minimum temperature in the open fell below 30° F. in different parts of India. From this chart it may be seen that the number of days in January when the minimum temperature in the open may be expected to fall below 30° F. will be roughly as given in Table II.

TABLE I.

| Name of Station | Mean depression °F | Name of Station | Mean depression °F |
|---|---|---|---|
| Murree | 10·9 | Sibsagar | 5·2 |
| Lahore | 9·5 | Nagpur | 13·4 |
| Ludhiana | 10·1 | Deesa | 8·9 |
| Jeypore | 9·8 | Bombay | 10·1 |
| Mount Abu | 16·5 | Poona | 13·2 |
| Ranikhet | 13·6 | Vizagapatam | 11·8 |
| Lucknow | 8·7 | Madras | 3·9 |
| Allahabad | 11·4 | Wellington | 8·6 |
| Hazaribag | 9·9 | Rangoon | 7·4 |
| Calcutta | 9·2 | Leh | 11·8 |
| Saugar Island | 9·3 | Aden | 3·1 |
| Dhubri | 7·4 | | |

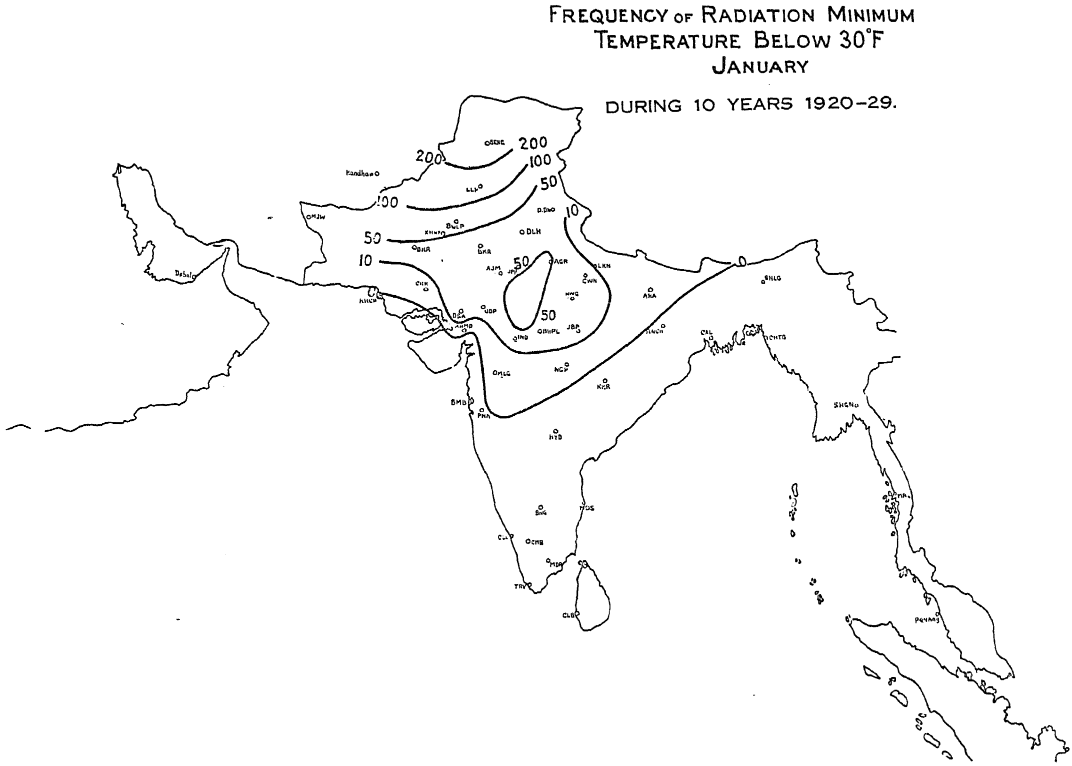


**Fig. 3.**

TABLE II.

| Area | Number of days in the month of January when radiation minimum temperature is likely to fall below 30°F. |
|---|---|
| 1. Kashmir and adjacent areas | 20 days |
| 2. Punjab (North) | 10 to 20 days |
| 3. Punjab (South) | 5 to 10 days |
| 4. Sind (excluding coastal tracts), Rajputana, Central India and West United Provinces. | 1 to 5 days |
| 5. Bombay Deccan, Northern portion of H.E.H. the Nizam's Dominions, East U.P., Bihar and a portion of North Bengal | 0 to 1 day |
| 6. Rest of Peninsula including the coastal districts of Sind. Kathiawar and the plains of Bengal | Nil |

So far we have been considering the radiation minimum temperature 2 or 3″ above the ground. The present writer and his associates[4,5] have found that even at the minimum temperature epoch in winter the temperature of the bare soil surface is higher than that of the air in contact with it and that the lowest air temperature occurs at some height above the ground. This level is usually about 6″ above the ground in the open and between 1 to 3 ft. above the ground inside crops, depending upon the plant population and height of the crop. The above results are obtained inside both irrigated and unirrigated crops. These temperature measurements were taken with the Assmann Psychrometer at the Agricultural Meteorological Observatory in the Agricultural College Farm, Poona, and refer to the air temperature. Radiation minimum temperatures taken with the help of "radiation minimum thermometers" exposed at various heights above the ground are found

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4 Ramdas, L. A., and Atmanathan, S., *Gerlands Beitrage Zur Geophysik.*, 1932, **37**, 116-117.

5 Ramdas, L. A., Kalamkar, R. J., and Gadre, K. M., *Indian Journal of Agricultural Science*, 1934, **4**, 451-467.

to be lower than the Assmann readings but they also behave similarly, *i.e.*, the lowest temperature is recorded by the instrument kept a few inches above the ground and not the one nearest to the ground. Table III gives the mean values of the soil surface temperature (minimum) and the air temperatures (taken with an Assmann Psychrometer at the minimum temperature epoch) as well as the radiation minimum temperatures at different heights above ground for the month of January 1934.

TABLE III.

| Height above ground | Air Temperature °F. | Radiation Minimum Temperature °F. |
|---|---|---|
| 0 (soil surface) | 51·2 | 51·2 |
| 0·4″ | 48·0 | .. |
| 1″ | 47·1 | 44·2 |
| 3″ | 46·8 | 43·5 |
| 6″ | 46·8 | 43·9 |
| 1 ft. | 46·9 | 44·1 |
| 3 ft. | 48·6 | 44·5 |
| | | The radiation minimum temperature over a grass plot, at a height of about 2″ above the soil surface was only 41·8 °F. |

In the calculation of the means in the above table for the month of January 1934, a few cloudy days have also been included. On especially clear and calm nights the temperature contrast between the layer of coldest air and the air layers above and below it is much more pronounced. A few such instances are given in Table IV.

TABLE IV.

| Height above ground | Air temperature in °F. at the minimum temperature epoch taken with an Assmann Psychrometer in January 1934 on | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 13 | 14 | 17 | 20 | 31 |
| 0·4″ | 44·8 | 36·0 | 33·8 | 40·1 | 46·0 | 37·0 |
| 1″ | 43·3 | 34·7 | 32·9 | 37·9 | 44·6 | 34·0 |
| 3″ | 43·0 | 34·0 | *32·0* | 37·2 | 43·7 | 33·8 |
| 6″ | 42·6 | *34·0* | 32·9 | *37·0* | *42·8* | 38·8 |
| 1 ft. | *42·4* | 34·0 | 32·9 | 37·4 | 44·6 | *33·8* |
| 2 ft. | 44·1 | 35·2 | 32·9 | 37·8 | 45·7 | 35·4 |
| 3 ft. | 45·0 | 35·6 | 33·8 | 40·5 | 46·4 | 37·4 |
| 4 ft. | 45·5 | 35·8 | 35·2 | 41·7 | 47·7 | 37·4 |
| | | Frost observed. | | | | |

COLD WAVE WARNINGS AND PROTECTIVE MEASURES.

From the daily weather charts it is generally possible to give prior warnings for the incidence of cold waves. Such warnings were issued by the Forecasting Section of the Meteorological Office at Poona, to Mr. K. V. Joshi, Deputy Director of Agriculture, Nasik, well in advance of the cold waves which affected his area both during January 1934 and 1935. Mr. Joshi had made arrangements to disseminate the warnings promptly. The grape-growers of this district are reported to have appreciated these warnings as they could attempt to take some precautions to safeguard their crops.

The series of charts in Fig. 4 show the departure of the mean temperature of day from normal for the period 13th to 20th January 1935. The passage of the cold wave through the country (this was associated as usually with a western depression) is well illustrated by these diagrams. It will be noticed that the departures from the normal were up to 16° F. after the wave entered India.

Besides disseminating the warnings it is also important to tell the cultivator how best he may take advantage of them. Although suggestions for protective measures had been made it was found that the measures taken by the grape-growers were very inadequate to resist the damaging effects of the cold wave this year. Some farmers had a few dull and smoky fires lit up at the fringes of the garden and these had very little effect even in their immediate neighbourhood on account of the wind. The effect of irrigation has not been found to be significantly beneficial this year. Wind breaks of jowar stalks were found to be of no use. One or two grape gardens which escaped with light damage had apparently the natural advantage of road-side avenues (which served as wind breaks) or of higher elevation or of slopes where cold air will not stagnate.

The whole problem of frost prevention inside crops is one which awaits further experimental work so far as its practical aspects under Indian conditions are concerned. At present we have no working knowledge of the measures that may be economically adopted for the prevention of frost-damage in India.

The main steps in any attempts to conserve heat inside gardens are :—

(1) Prevention of air movement: during intense cold waves in winter there is fairly strong air movement near the ground, especially during the initial period; protective measures like fires will not be effective unless the air movement is checked by an adequate system of wind breaks.

(2) Burning *bright* fires in adequate numbers: they should be uniformly distributed inside the garden; to afford protection to marginal plants there should be an extra line of fires at the outskirts of the garden.

The experience in the United States of America, where a very large amount of work on protective measures against frost has been done is that other methods like irrigation or placing covers may afford temporary relief under mild and short spells of frost but are of little use during intense

Charts showing departure of mean temperature of day from normal from 13-1-1935 to 20-1-1935.

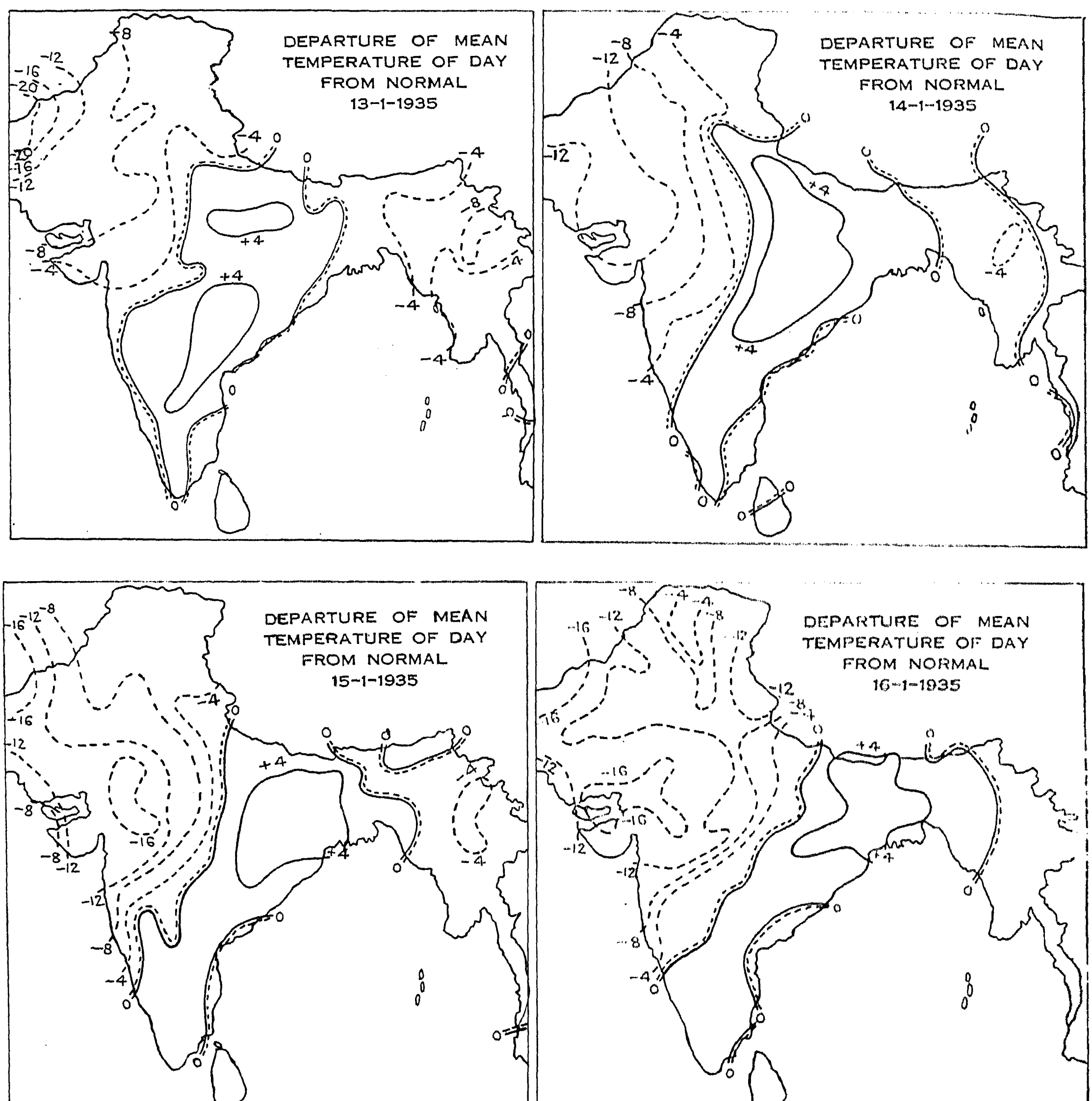


**Fig. 4.**

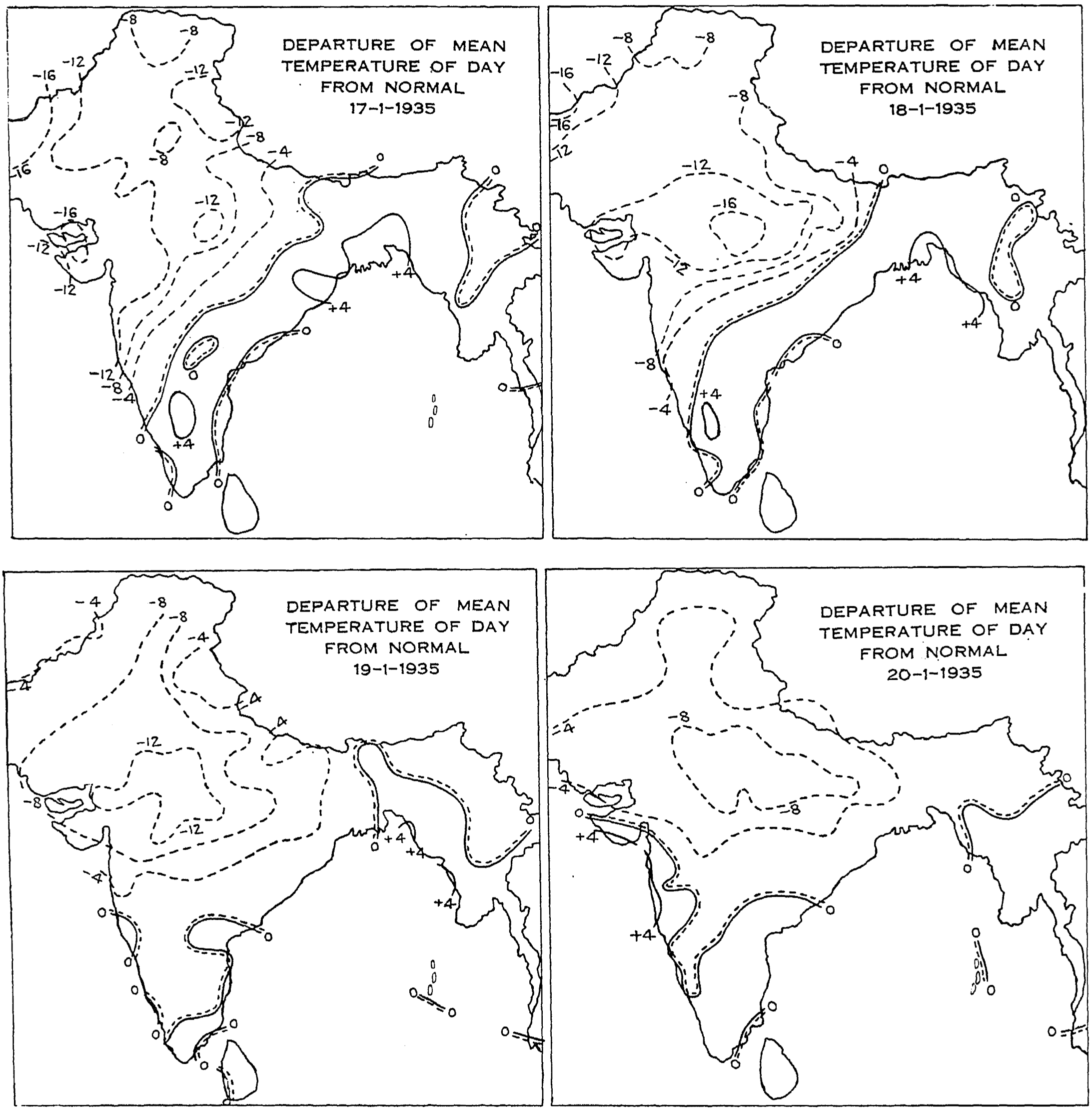


**Fig. 4.**—(*Contd.*)

frosts lasting for a few days, like the one which was experienced recently in many parts of North-West India, Gujarat and the Bombay Deccan.

The actual extent and distribution of the damage to different crops are being ascertained and the writer hopes to discuss the effects of this year's cold wave in greater detail in collaboration with Mr. K. V. Joshi and others.

A few photographs taken this year during the cold wave may be of interest. Figs. 5 (*a*) and (*b*) show an undamaged and a damaged guava plant; Figs. 5 (*c*) and (*d*) show an undamaged and a damaged bush of vine. Figs. 6 (*a*) and (*b*) show the meteorological instruments kept inside the vine-garden of Mr. Phadatre (Nasik), and a wind break of dry jowar which proved ineffective respectively.

The camp observatory (see Fig. 6*a*) consisted of one set of instruments inside a garden and a similar set exposed in an open space near by.

The observatory was set up at Nasik early in January by the Agricultural Meteorology Branch with the co-operation of Mr. K. V. Joshi, Deputy Director of Agriculture.

**Fig. 5**(*a*).
Healthy guava plant.

**Fig. 5**(*b*).
Guava plant affected by frost.

**Fig. 5**(*c*).
A healthy vine.

**Fig. 5**(*d*).
Vine affected by frost.

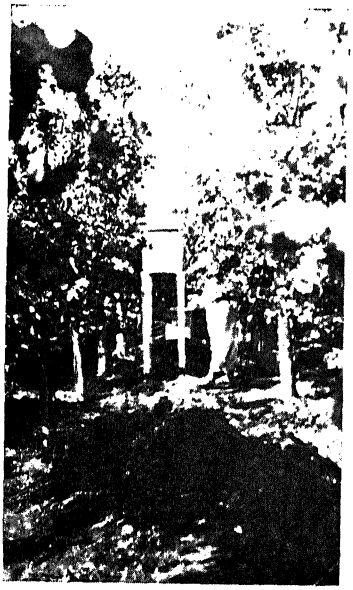

**Fig. 6**(*a*).
Camp Observatory inside vine-yard.

**Fig. 6**(*b*).
Jowar wind-breaks.

Figs. 7 (*a*) and (*b*) show the hourly march of the percentage humidity and the air temperature respectively from 0800 hours of the 15th to 0800 hours of the 16th January when the cold wave was most intense. The records were obtained from hygro-graphs and thermo-graphs kept inside two Stevenson screens which were placed on the ground. The dotted curves refer to conditions inside the vine-garden while the full lines refer to conditions outside in the open. It will be noticed that the air inside the garden was

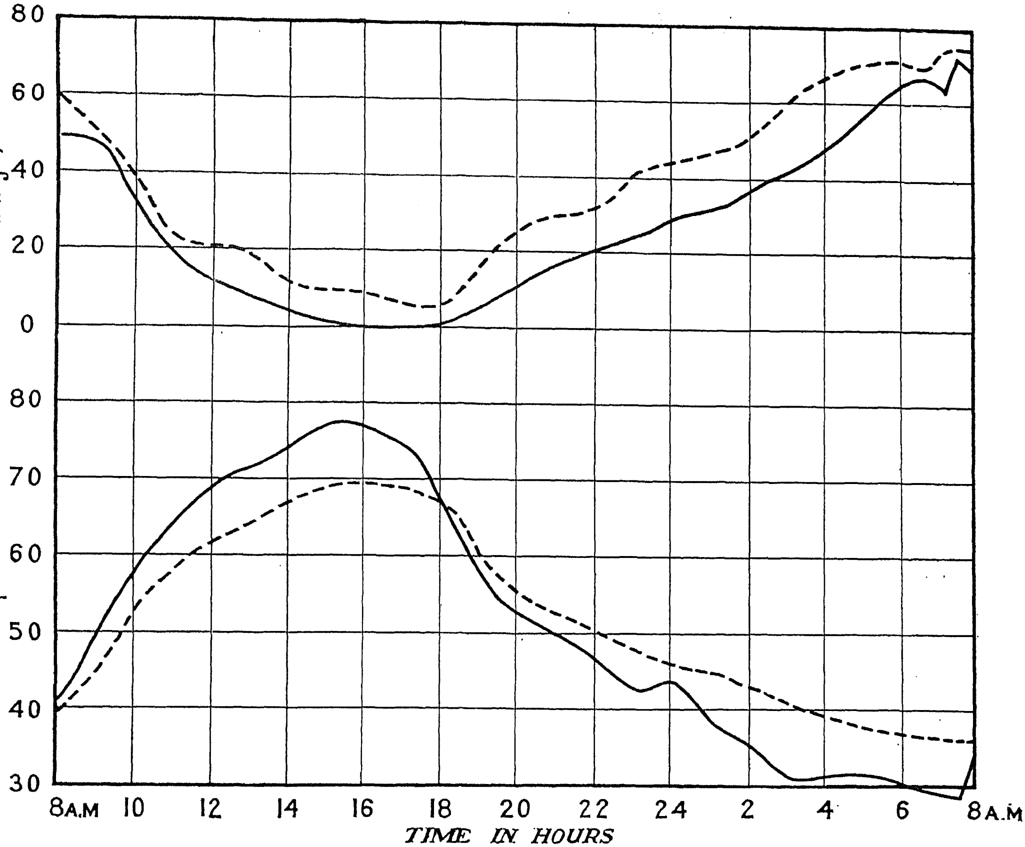


**Fig. 7.**

Hourly variations of humidity and temperature from 8 A.M. of 15-1-1935 to 8 A.M. of 16-1-1935 at Nasik Full lines refer to conditions inside a screen kept at ground level in the open. Dotted lines refer to conditions inside a grape garden in a similar screen at ground level.

more humid than outside at all hours and that the temperature was lower inside the garden than in the open during the day hours but higher during the night. The air temperature near the soil in the open was below 32° F. for nearly five hours on the 16th morning (0245 to 0745). Another noticeable feature is the extreme dryness of the air, *e.g.*, the percentage humidity was practically zero on the afternoon of the 15th. The data collected at Nasik will be discussed in greater detail elsewhere.

It is hoped that in the years to come the joint efforts of the Agricultural and the Meteorological Departments will help to solve the problem of frost prevention. The prevention of frost damage inside gardens will be more practicable economically than in the more extensive field crops; a beginning may be made at Nasik where the grape interests are concentrated over a small area. Adequate funds for detailed experiments on the efficacy of fires, wind-breaks, topography, etc., will be required for undertaking such joint investigations.

# The Cold Wave of January 1935.

By Dr. S. C. Roy,
*Colaba Observatory, Bombay.*

THE cold spell experienced in north and central India during the first and the second week of January this year appears to have broken all past records when both intensity and duration are taken into account. The cold wave of Jan.—Feb. 1929 which created new records of low temperatures at many Indian observatories is comparable to the 1935 spell in intensity but lasted for a much shorter period. A comparative statement of the lowest temperatures recorded at representative stations in the plains of north-west and central India in 1929 and 1935 is given in the following two tables.

TABLE I.

COLD SPELL OF JAN., 1935.

*Air-Minimum 4 ft. above Ground (°F.)*

| Station | Jan. 12 | Jan. 13 | Jan. 14 | Jan. 15 | Jan. 16 | Jan. 17 | Jan. 18 | Jan. 19 | Jan. 20 | Number of days with air-minimum below 32° F. |
|---|---|---|---|---|---|---|---|---|---|---|
| Peshawar (N.W.F.) . . | 34 | *29* | 32 | 38 | 32 | 31 | 32 | 33 | 40 | 5 |
| Khanpur (W. Punjab) | 31 | 31 | *29* | *29* | 33 | 31 | *29* | 32 | 35 | 7 |
| Lahore (E. Punjab) . . | 34 | 31 | 31 | 29 | 32 | *28* | *28* | *28* | 33 | 7 |
| Agra (U.P.) . . | 47 | 44 | 37 | 34 | *28* | 33 | 31 | 30 | 33 | 3 |
| Hyderabad (Sind) . . | 45 | 42 | *34* | 36 | 38 | 39 | 41 | 42 | 45 | . . |
| Deesa (Gujarat) . . | 55 | 39 | 33 | *28* | 30 | 35 | 40 | 38 | 46 | 2 |
| Jodhpur (W. Rajputana) . . | 44 | 37 | 36 | *30* | 33 | 41 | 40 | 41 | 45 | 1 |
| Ajmer (E. Rajputana) | 52 | 30 | 34 | *27* | *27* | 31 | 35 | 35 | 34 | 3 |
| Indore (W.C.I.) . . | 54 | 43 | 37 | 31 | *30* | 34 | 36 | 41 | 44 | 2 |
| Nowgong (E.C.I.) . . | 49 | 49 | 43 | 35 | 32 | 32 | 31 | *29* | 31 | 5 |
| Malegaon (N. Bombay, Deccan) . . | 55 | 46 | 37 | *33* | *33* | 36 | 37 | 48 | 51 | . . |
| Poona (S. Bombay, Deccan) . . . . | 54 | 50 | 44 | 41 | 37 | *35* | 38 | 49 | 52 | . . |

TABLE II.

COLD SPELL OF JAN.-FEB., 1929.

*Air-Minimum 4 ft. above Ground (°F.)*

| Station | Jan. 29 | Jan. 30 | Jan. 31 | Feb. 1 | Feb. 2 | Feb. 3 | Number of days with air-minimum below 30° F. |
|---|---|---|---|---|---|---|---|
| Peshawar (N.W.F.) . . | 36 | 33 | 34 | *31* | 33 | 37 | 1 |
| Khanpur (W. Punjab) . . | 31 | 27 | 26 | *24* | 27 | 36 | 5 |
| Lahore (E. Punjab) . . . . | 39 | 38 | *29* | 32 | 31 | 31 | 3 |
| Agra (U.P.) . . . . | 44 | 47 | 33 | *29* | 30 | 39 | 2 |
| Hyderabad (Sind) . . . . | 42 | 36 | 30 | 36 | 40 | 47 | 1 |
| Deesa (Gujarat) . . . . | 42 | 39 | 34 | *31* | 36 | 51 | 1 |
| Jodhpur (W.Rajputana) . . | 46 | 35 | *30* | 33 | 38 | 40 | 1 |
| Ajmer (E. Rajputana) . . | 38 | 38 | *27* | 31 | 33 | 40 | 2 |
| Indore (W.C.I.) . . . . | 45 | 49 | 34 | *27* | 36 | 43 | 1 |
| Nowgong (E.C.I.) . . . . | 50 | 49 | 46 | *32* | *32* | 37 | 2 |
| Malegaon (N. Bombay, Deccan) | 47 | 54 | 34 | *31* | 34 | 47 | 1 |
| Poona (S. Bombay, Deccan) . . | 50 | 49 | 45 | *40* | 42 | 50 | . . |

These tables indicate briefly the intensity, duration and the progress of the two cold waves. It is seen from the above tables that the 1935 cold spell has been worse than the 1929 spell both in intensity and duration throughout north-west and central India outside the south-west Punjab and the adjoining parts of Sind.

The figures given in the tables represent the temperature of air at a height of about 4 ft. above the ground but temperature near the ground must have been several degrees lower. The grass-minimum temperature would have given a better estimate of the severity of the cold waves but such data are not available for all representative stations in India. Below is given a comparative statement of the air-minimum and grass-minimum temperatures as registered at Colaba during the last cold spell.

TABLE III.

| Date | Air Minimum Temperature | Grass-Minimum Temperature |
|---|---|---|
| 1935 | | |
| Jan. 14 | 60°·4 | 46°·5 |
| „ 15 | 53°·1 | 39°·2 |
| „ 16 | 54°·5 | 40°·1 |
| „ 17 | 53°·8 | 40°·1 |
| „ 18 | 57°·8 | 45°·1 |

It will be seen from the above data that the grass-minimum temperature was about 13 to 14 degrees below the air-minimum temperature at Colaba during the cold wave. Neglecting uncertainties of a few degrees the same must have been true at all other representative stations given in Table I. Three or four degrees of frost in terms of the air-minimum temperature may, therefore, really mean 15 to 20 degrees of frost near the ground. Such a degree of frost cannot but be damaging to tender plants, crops and vegetables. It is, therefore, not surprising that reports of damage to crops are already appearing in the Press but we may have to await further reports to form a comprehensive estimate of the damage done by the last cold wave.

The results of a few soundings taken over Agra during the passage of the 1929 cold wave enabled Mr. G. Chatterjee and the present writer[1] to make an inference in regard to the origin of that cold wave. During winter the normal height of the tropopause over Agra (Lat. 27° N.) is about 14.5 gkm. and its temperature is 260° absolute[2] while with the invasion of the 1929 cold wave, the base of the Agra stratosphere came down so low as 11·5 gkm. and its temperature rose to 213° absolute. The conditions in the troposphere and the stratosphere over Agra during the 1929 cold spell were similar to those normally found at about Lat. 40° N. The trajectories of the pilot balloon flights indicated that the cold air came from the north-west. It was, therefore, inferred that the cold wave of 1929 had its origin somewhere to the east of the Caspian Sea. Sounding balloon data during the last cold wave are not available yet. It would be interesting if soundings over Agra during the last cold spell confirm the 1929 observations.

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[1] *Nature*, 1929, **124**, 579.

[2] Ramanathan, *Nature*, 1929, **123**, 834. (See Fig. 1.)

# Modification of Swim-Bladder in Certain Air-Breathing Fishes of India.*

By Sunder Lal Hora, D.SC., F.R.S.E., F.A.S.B.,
*Zoological Survey of India, Calcutta.*

IN a general sense, the swim-bladder of fishes performs a hydrostatic function, but there are many structural anomalies which have neither been explained nor correlated with any variations in the habits of their possessors. In 1830, Taylor† directed attention to the modifications of the bladder in certain air-breathing fishes of India, but, so far as I am aware, these modifications have not been correlated with the habits of the fishes. For carrying out certain physiological experiments, several kinds of air-breathing fishes were kept in aquaria and it was observed that different species behaved differently when at rest. For instance, *Heteropneustes* (=*Saccobranchus*) floated in any position with its dorsal surface directed upwards; *Clarias* and *Amphipnous* floated vertically so long as their air-chambers were full of air; while *Ophicephalus* and *Anabas* did not float at all even after taking a fresh supply of air in their respiratory chambers; they lay quietly at the bottom for most of the time. For an explanation of their behaviour, I studied the form of their swim-bladder with the following results.

With the development of additional receptacles for the storage of air for respiration, it is evident that some adjustment of the hydrostatic organs had to take place. In *Clarias* and *Amphipnous*, the air-chambers are at the anterior end, and as the habit of these fishes is to lie suspended vertically for most of the time, they can keep the anterior end buoyant with the help of the air-chambers. A bladder in the abdominal cavity would have been a disturbing factor under the circumstances and is, therefore, either greatly reduced or lost altogether. *Ophicephalus* and *Anabas*, in spite of the extensive air-cavities in the head, are enabled to lie at the bottom by the extension of the swim-bladder in their caudal region. Thus the development of the buoyant chambers at the anterior end is balanced by the portion of the air-bladder enclosed in the caudal region. The long, dorsal tubes of *Heteropneustes* replace the ventral swim-bladder which becomes greatly reduced and enclosed in bone. The fish is enabled by the tubes to float or lie at the bottom, as the buoyant area is thus uniformly distributed all over the surface of the fish.

The study of the estuarine Gobioid fishes,‡ all of which are capable of aerial respiration under adverse circumstances, also leads to the conclusion that definite correlation exists between the form and position of the bladder and the mode of life of the different species. *Glossogobius giurus*, *Eleotris fusca*, *Butis butis* and *Stigmatogobius sadanundio* swim about freely and, though capable of living out of water for some time, are in the main water-breathing fishes. and do not show any marked development of the gill-chambers. Consequently, the swim-bladder is extensive and of the normal type. *Pseudapocryptes lanceolatus*, *Apocryptes bato* and *Tænioides rubicundus* live in deep burrows, usually under water, and have developed large gill-chambers for aerial respiration under adverse circumstances. These eel-like fishes do not swim about and when the water is foul, they hang from the surface by distending their air-cavities (gill-chambers) with air. Under the circumstances, the bladder is of little use and, in consequence, it is greatly reduced. *Periophthalmodon*, *Periophthalmus* and *Boleophthalmus* are almost terrestrial in their habits and possess well-developed cheek-pouches for the storage of air. The air-bladder is absent in these genera.

From the above it is clear that the size and position of the swim-bladder in fishes are definitely correlated with their mode of life, and the structural modifications, referred to above, especially in the case of the freshwater air-breathing fishes, are, no doubt, induced by the presence of air-chambers. These observations lend considerable weight to the view that the present chief function of the swim-bladder is to act as a hydrostatic organ, for where other structures have appeared to interfere with this

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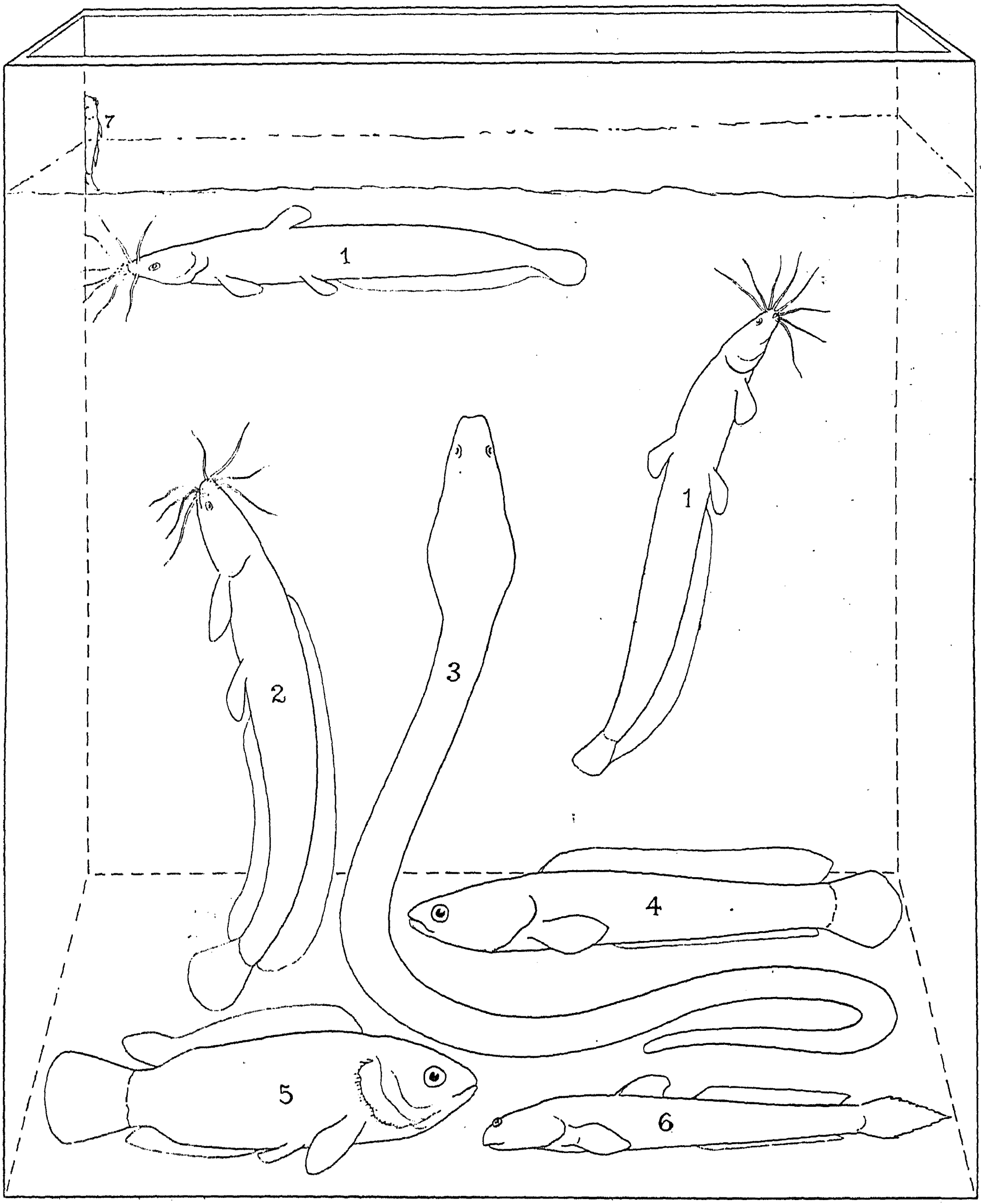
† Taylor, J., "On the Respiratory Organs and Air-Bladder of Certain Fishes of the Ganges," *Gleanings in Science*, 1830, 2, 169-176.

‡ Mr. Dev Dev Mukerji of the Zoological Survey of India is at present engaged in investigating the correlation between the structure of the air-bladder and the ecological factors in the case of Gobioid fishes in the Gangetic delta.




**Position at Rest of Certain Air-Breathing Fishes of India.**
(Diagrammatic.)

1. *Heteropneustes fossilis.*
2. *Clarias batrachus.*
3. *Amphipnous cuchia.*
4. *Ophicephalus punctatus.*
5. *Anabas testudineus.*
6. *Pseudapocryptes lanceolatus.*
7. *Periophthalmodon schlosseri.*

function, the bladder has either disappeared functionally§ or has become greatly modified to meet the new requirements. The probable mode of origin of the type of air-bladder found in *Anabas* and *Ophicephalus* is discussed below.

The extension of the air-bladder in the caudal region among the Anabantidæ and the Ophicephalidæ is a remarkable morphological feature of these fishes. It has been indicated above that they are provided with extensive chambers in the head region for storing air for respiration and, in spite of these buoyant structures at the anterior end, they spend most of their time lying horizontally at the bottom. To reconcile these two facts, one has to imagine a type of fish before the development of the air-chambers. In an ordinary fish, the air-bladder is situated in the abdominal cavity and the fish is enabled to move up and down or lie at the bottom without feeling inconvenienced. The ancestors of the Anabantidæ and the Ophicephalidæ were probably bottom fishes. When they developed the habit of breathing air and storing it in cavities in the head, the anterior end became buoyant, so, for bottom life, they had to spend a great deal of energy to keep the front end down. Thus, such a fish had to swim almost constantly with the head directed downwards and the body inclined at an angle. Under these circumstances, the air in the air-bladder began to exert some pressure on the neighbouring ventral muscles of the caudal region which gave way and enabled the extension of the bladder backwards. This process must have continued for some time, till the buoyant tendencies of the anterior part of the fish were balanced by the extension of the bladder right up to the base of the caudal fin and it could lie at the bottom without any exertion.

The origin of the air tubes of *Heteropneustes* and of the air-bladder in fishes has to be traced to a similar habit. In the beginning, these structures probably developed as small pouches for storing air in the head region and when the anterior end became buoyant and the fish had to struggle for lying at the bottom, the backward extension of these pouches resulted in the setting up of the proper equilibrium. These observations lend support to the view that air-bladder probably developed as an organ of aerial respiration and that its present hydrostatic function is only a secondary acquisition.

§ *Clarias* and *Heteropneustes* (=*Saccobranchus*) are generally regarded as mud-inhabiting fishes of India. Though capable of living in mud when the water dries up, they are by no means mud-fishes, for they keep floating in water, usually near the bottom. It was under a misapprehension, therefore, that I (*Proc. 17th Ind. Sci. Cong.*, 1930, 229-243) attributed the reduction of the air-bladder in these fishes to a ground habit of life. The most plausible reason for the reduction of the bladder is to be found in the development of air-chambers and the floating habit of these fishes.

These observations show how identical modifications sometimes result from widely different causes, and, in consequence, the great need of field observations in the study of adaptations—correlation of form and habits. Cases are known of divergent modifications under similar environmental conditions (Hora, *Phil. Trans. Roy. Soc. London* (B), 1930 *a*, **218**, 266), and in the case of the reduction of air-bladder in fishes similar modifications have resulted from different causes. The result in all cases is the adjustment of an organism to the external conditions of its existence.

## Institute of Oil Technology, Nagpur.

THE Committee appointed by the Nagpur University in April 1933 to investigate the economic potentialities of the development of Oil Technology in Central Provinces and Berar, have recently issued their Report. The Committee recommend the establishment of an Institute at a capital cost of 3·5 lakhs of Rupees and an annual recurring expenditure of 51,000 Rupees. The Institute will provide a three-year course leading to the B.Sc. Degree in Technology and a one-year course leading to the M.Sc. Degree. Provision is made for 36 under-graduate and 12 post-graduate students. The course of study includes Chemical Technology and Engineering, Physics and Mathematics bearing on engineering problems, commercial economics, accountancy and industrial administration. Plants for the manufacture of soaps, candles, paints and varnishes will be erected so as to afford training of a semi-commercial character to students. If run on commercial basis, the plant is expected to pay its own way. It is hoped that with the help of the Lakshminarayan Bequest, the University will soon be able to establish the Institute.

# Some Recent Advances in Indian Geology.*

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## 4. The Geology of Burma.

DURING the past fifteen years a considerable advance has been made in our knowledge of the geology of Burma, and although valuable contributions have been made by workers outside the Geological Survey of India, especially concerning the Tertiary oil belt, for the most part the progress has been mainly due to the official survey. In order, therefore, to follow the progress made in Burma during recent years, it is necessary to follow the activities of the official survey in the province.

Since 1920, about when systematic survey operations were resumed in Burma after a lapse of several years, large tracts of the country have been mapped on the standard topographical sheets of the scale of one inch to one mile. For several years in the beginning of the period practically the whole strength of the Burma party was devoted to the mapping of the Tertiary belt. But later on, while this work continued, activities became scattered over areas so wide apart as Mogok and Myitkyina in the north, Amherst and Mergui in the south, and the Shan Plateau on the east. These centres of investigation are geologically so distinct and independent of each other that our best course will be to follow the trend of investigation in each separately.

### THE TERTIARY BELT.

Since Sir Edwin Pascoe's classic memoir on the oilfields of Burma,[1] the most important contribution to our knowledge of the history of Tertiary deposition in Burma has been made by G. de P. Cotter with the help of his colleagues, through their field work in the foot-hills of the Arakan Yoma in Upper Burma, and through the valuable palæontological researches of E. W. Vredenburg.[2] The record of the Tertiary sequence on the eastern flanks of the Arakan Yoma is preserved so fully that it really constitutes the key to the history of deposition in the Tertiary Era in the province. Cotter was able to prove through his work in the western parts of the Minbu district that the Arakan Yoma existed as a narrow strip of land at the commencement of the Tertiary, and was able to demonstrate a lateral as well as vertical variation of rock facies according to which each stage is represented by a gradually shallower condition of deposition when followed northwards, the variation amounting to replacement of the marine by estuarine and fresh-water beds. Research along those lines led Cotter to the important conclusion that the Tertiary basin of deposition was in reality a typical geosynclinal area lying between the Shan Plateau and the narrow strip of land representing the Arakan Yoma, and that as the head of the gulf that occupied it gradually filled up in the north, where the major portion of the sediments came from, the sea retreated to the south. Thus the fluviatile sediments and deltaic deposits kept continually advancing southwards pushing the sea before them, and at the same time the area of subsidence also kept shifting to the south. Cotter published his views in 1918, and it is necessary to refer to them here since his conception of the history of Tertiary deposition has formed the basis of subsequent research in this line.

In a series of papers from 1922 onwards L. Dudley Stamp attempted to elaborate the original conception of Cotter with slight modifications and additions of detail.[3] In 1922 he emphasised the existence of intermittent folding movements at an early stage in the evolution of the geosyncline, which caused further elevation of the Arakan Yoma and further depression and buckling of the floor of the geosyncline, resulting in the temporary returns northward of marine conditions that have left wedges of marine sediments in between layers of continental type. Subsequently he postulated a marked variation between the time-planes and the lithological planes,[4] and advocated a grouping on the basis of cycles of marine invasion.[5] At the same time he suggested a modification of Vredenburg's sub-division of the Pegu Series. But these views have not found

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[1] *Mem. Geol. Surv. Ind.*, 1912, **40**, 1-269.

[2] *Journ. As. Soc. Beng.*, 1918, **14**, 409.

[3] *Geol. Mag.*, 1922, **59**, 481.

[4] *Op. cit.*, 1925, **62**, 515.

[5] *Trans. Min. Geol. Inst. Ind.*, 1923, **17**, 161.

support in more recent work, as we shall see presently. They are mentioned here only to show the different lines that have been explored in recent years to arrive at a satisfactory understanding of the Tertiary sequence in Burma.

At the World Petroleum Congress held in London in July 1933, G. W. Lepper of the Burma Oil Company Limited, briefly outlined the Tertiary geology of Burma, and contributed a large amount of hitherto unpublished information based on the results of many years' incessant work by the geological staff of the Company.[6] This contribution, therefore, is of unusual authority and interest, and carries us a long way in our knowledge of the sequence and structure of the Tertiary deposits of Burma and the connection of the latter with the occurrences of commercial petroleum. P. Evans summarised the paper recently,[7] but some points of unusual interest must be mentioned here even at the risk of repetition.

A very important point brought out by Lepper is the recognition of a long synclinal trough which forms a striking feature of the geological structure of the Chindwin-Irrawaddy Valley, and which separates the western monocline, composed of a complete succession of the Tertiary deposits flanking the Arakan Yoma, from a broad series of folds to the east. This structure is found to persist from latitude 24° (west of the Indaw anticline) in the north, across the Chindwin River near Mingin, to the west of the Mahudaung anticline. From there it runs through the Pakokku district and the oilfields, into the Thayetmyo district in the south, where it narrows and becomes split up by anticlinal folds running across its strike. It reaches its maximum development west of the Yenangyaung and Singu-Lanywa-Yenangyat oilfields, and separates these and the Minbu oilfield from the monoclinal succession in the west. This median syncline is of very great importance not from the structural point of view alone but because the occurrence of commercial petroleum is closely connected with it. It has been established that all the producing fields lie in the closed structures that border the synclinal immediately on the east, and with the exception of the Indaw oilfield, situated near its north end, the main group of oilfields lies near its maximum development opposite Yenangyaung. According to Lepper circumstances similar to those attending the origin and migration of oil in some of the American fields, as explained by V. C. Illing,[8] may have prevailed in Burma from Middle Eocene to Middle Miocene. Conditions favourable for the accumulation of organic matter suitable for the formation of petroleum persisted more continuously in the shallow marine tract occupied by the synclinal, where thinner sediments were deposited, than on its east and west. And with the compaction of the strata oil and salt water were expressed and moved laterally to the coarser deposits of the margins. Uplift of the latter initiated the segregation of gas, oil and salt water during the post-Pliocene folding. Thus we find oil in quantity confined to the belt of folds that lie immediately to the east of the syncline. Beyond this belt the oil seepages are rare and test wells have struck little or no oil. The oil which migrated towards the western margin of the syncline had no opportunity to accumulate as no closed structures exist on that side.

Another equally interesting contribution made by Lepper gives the result of a close examination of the whole Tertiary sequence forming the long easterly-dipping monocline along the eastern flank of the Arakan Yoma. Members of the Pegu Series (Oligo-Miocene) were found to become more arenaceous when followed northwards, as demonstrated by Cotter, but in addition well-defined palæontological breaks are recognised at the top of the Yaw Stage (Eocene), and between the Oligocene and Miocene, the latter break dividing the Pegus into two parts of equal thickness. Another widespread unconformity is recorded between the Irrawaddy series (Mio-Pliocene) and the Pegu series, and a new classification has been suggested.[9]

An important result of these researches is that the divergence of time-planes and lithological planes advocated by Stamp all these years does not find support in the evidence brought forward by Lepper. With the present facilities of coring the underground strata of the central oilfields by rotary drilling it has become increasingly possible to correlate the stratigraphical sequence of this area with that of the outcrops west of the syncline, in spite of the difficulties raised

[6] World Petroleum Congress, London, 1933, reprint 169.

[7] *Trans. Min. Geol. Inst. Ind.*, 1934, **29**, 67.

[8] *Journ. Inst. Petr. Tech.*, 1933, **19**, 229.

[9] See Reference 6.

by lateral lithological variations of the beds from west to east.

As regards the progress which has been made during recent years in the oilfields development, the reader is referred to the proceedings of the World Petroleum Congress of 1933, and to the annual reports of the Director, Geological Survey of India, since 1927, when the practice of having a Resident Geologist permanently at Yenangyaung was revived.

THE TERTIARY IGNEOUS ROCKS OF BURMA.

Tertiary igneous activity in Burma began in Eocene times, and with intermittent quiescent periods of varying duration revived in early Irrawaddy (Mio-Pliocene) and again in Pleistocene and sub-recent times. The different periods of activity are remarkable more for the extent in space over which the phenomena are exhibited than for the amount of material poured out, and all the successive activities appear to have followed more or less the same tectonic lines from beginning to end. The present-day surface indications suggest that the later activities were the more energetic and, although still following the older zones, their manifestations extended far beyond the earlier limits.

The most important centres of activity are seen to follow an important tectonic line that traverses the entire length of Burma and runs approximately through the centre of the Irrawaddy-Chindwin basin. Beginning with the Myitkyina occurrences in the north it runs through the Mingin Range volcanics west of Wuntho, to the explosion craters of the Lower Chindwin district, and from there it continues south through the Shinmadaung hill range in Pakokku district, and through Mount Popa to the dolerite dykes and sills of the Pegu Yoma. When continued further south this line passes through the volcanic islands of Narcondam and Barren to the volcanic regions of Sumatra. In the Lower Chindwin district a subsidiary line runs parallel to it, in the hill ranges east of Monywa.

Another line, though of less importance, runs along the western edge of the Shan Plateau. Along this line are found the intrusive and extrusive rocks of the Male-Kabwet area in the Shwebo district in the north, the rhyolites and tuffs in Thaton, the volcanics of Maingy and Elphinstone Islands off the coast of Tavoy, and the basalts of Medaw Island south of Murgyi. Only a very short account of the various centres of activity in which research has been carried out in the period of the present review can be attempted here, beginning in the north.

H. L. Chhibber, during his recent work in the Jada Mines area in the Myitkyina district, which is the point furthest north at which Tertiary igneous rocks have so far been mapped, found the extinct volcano of Mount Loimye, which rises 5,124 feet above the sea-level, and is thus higher than Mount Popa which it somewhat resembles in its structure and ejectamenta.[10]

Although the volcanic rocks of the Mingin Range form the biggest centre of vulcanicity in Burma, practically nothing has been added to Noetling's description of long ago.[11]

In Lower Chindwin district there is a belt of volcanic occurrences 25 miles wide, following roughly a N.–S. direction. It includes the string of eleven extinct explosion-craters situated in a straight line, some 13 miles long, running across the Chindwin river at Shwezaye in a N.E.–S.W. direction. From the spectacular point of view they form the most interesting occurrence, being represented by great hollow pits the bottoms of most of which are now covered by lakes. R. D. Oldham[12] was the first to describe these explosion-craters, and so far as the description of surface features goes his observations can hardly be improved upon, though the rocks themselves have since been studied in greater detail. In 1925 P. Kelterborn published a short note on some specimens collected from this area.[13] In 1927 Messrs. Pinfold, Day, Stamp and Chhibber described the igneous rocks of the whole district,[14] while during 1926-28 the writer mapped these occurrences in the course of the systematic mapping of these districts. The most important account, however, is the one given by C. Burri and H. Huber in 1932.[15] According to these workers the rock types include liparites, andesites, basalts, ultra-basic rocks, and tuffs and similar rocks. The olivine-basalts are the most widespread, and some of them have proved to be alkali basalts under-saturated with silica and containing normative nepheline. The ultra-

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[10] *Rec. Geol. Surv. Ind.*, 1930, **63**, 101.

[11] *Op. cit.*, 1893, **26**, 26.

[12] *Op. cit.*, 1906, 137.

[13] *Eclog. Geol. Helv.*, 1925, **19**, 352.

[14] *Trans. Min. Geol. Inst. Ind.*, 1927, **21**, 145.

[15] *Schweiz. Min. Petr. Mitt.*, 1932, **12**, 286.

basic rocks ejected by the Twindaung crater are represented by pyroxene-hornblendite which is found to contain by mode 85 per cent. hornblende and 15 per cent. pyroxene, approaching nepheline-basanite in chemical composition, and by biotite-pyroxenite which is found to contain 40 per cent. biotite and 60 per cent. augite, approaching leucite-basanite to olivine-leucitite in chemical composition.

In the hills west of Monywa devitrified rhyolites, quartz-porphyry and muscovite-porphyry have been recorded. The detailed survey of the part of the Lower Chindwin east of Monywa by the present writer in 1927-28 brought to light a few additional volcanic occurrences. Most of them are situated along a fault line that runs in an approximate N.-S. direction.

The next volcanic occurrences to the south are found in the Salingyi upland (sheet 84 0/1) mapped by Barber in 1925-26. The rocks here comprise dacites, dolerites and coarse diorite forming a suite of pronounced calc-alkali type. Further south the line passes through a small outcrop of lava exposed in the Shinmadaung hill range, along the western flanks of which hornblende-andesites, basalts, tuffs and rhyolitic agglomerates and breccia occur.

Although dolerite dykes and sills are known to occur in the Pegu Yoma further south, Mount Popa in the Mingyan district forms the most conspicuous southerly manifestation of late Tertiary volcanic activity in the Irrawaddy basin. A preliminary account of the lava flows of this area was given by Sir Edwin Pascoe in 1909, and more recently the rocks have been described by Chhibber.[16] Barber worked on the eastern slopes of the mountain in 1926 and the representative collections made from this area and from the Shinmadaung range and Salingyi area are at present being studied by him. Volcanic activity in this region probably commenced at an earlier time than elsewhere, although the period of maximum activity may be Irrawaddian.

Mount Popa itself is built of lava flows, tuffs and agglomerates of Pleistocene to sub-Recent age. Older volcanic rocks also occur and include a repetition of different types of andesites and rhyolitic rocks, both associated with tuffs. The different rock types in the younger lavas are all easily matched with one or the other of the types occurring in the Lower Chindwin, so that it is quite clear that igneous rocks in these two distant centres belong to the same petrographic province.

The most important centre of igneous activity on the second line—that following the western edge of the Shan Plateau, is the most northerly known occurrence, that of Male-Kabwat region. Stamp and Chhibber published an account of this area in 1927.[17] The present writer mapped the area in the course of his routine survey of the Shwebo district during the season of 1928–30, and whilst his mapping is mainly in agreement with that of Stamp and Chhibber, he made one noticeable addition by discovering that the anticlinal axis through Nattaung Hill and Letkokpin is followed by a parallel synclinal axis to the east running through Kabwet, and that the spheroidal lava regarded by Stamp and Chhibber as a dyke intrusion was in fact a sheet of lava, taking part in the fold and appearing on either limb of the syncline.

Records of more than one period of igneous activity are preserved here. The older lava is interbedded with the Irrawaddy beds and shows beautiful examples of pillow structure. Intrusions are represented by a sill and dykes, and the younger olivine basalts, extruded in Pleistocene or sub-Recent times, build the hill Lethataung, 1,674 feet above sea-level, opposite Kabwet. The peak is regarded by Stamp and Chhibber as marking the focus of eruption; but the writer is of opinion that those lavas came from fissures, one of which passed through the position that now forms the crest of the hill range of which Lethataung is the culminating point. The lavas of Singu to the south are part of the same extrusion. North of Kabwet the volcanic activity is represented by decomposed amygdaloidal lava interbedded with the Irrawaddy beds, and by the long lines of dolerite dykes between Kabwet and Male. This line of activity corresponds with a zone of tight folding and crushing of the late Tertiary beds against the crystalline rocks of the Mogok series, and the junction between the two is most probably a faulted one. A very interesting character of the rocks of this region is that they show an 'Atlantic' or alkaline tendency of differentiation, whereas the rocks of all the igneous centres on the main line

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16 *Trans. Min. Geol. Inst. Ind.*, 1927, **21**, 129.

17 *Op. cit.*, 1927, 97.

to the west show definite 'pacific' or calc-alkali affinities.

The next known area of vulcanicity along this line lies near Mokpalin, in the Thaton district, where rhyolites and rhyolitic tuffs are seen to overlie a sedimentary series of probably Carboniferous age.[18] They strongly resemble the occurrences west of Monywa in Lower Chindwin district, and are regarded as of the same age. Continuing along this line to the south we come to the coarse volcanic agglomerates of Maingy Island and a series of rhyolites and porphyries on the western coast of Elphinstone Island, off the Tavoy Coast. The age of these rocks is uncertain. The southernmost volcanic occurrence is that of the island of Medaw in Mergui, where basalt fills up most of the low-lying ground. The area was visited by M. Vinayak Rao in 1922,[19] and a description of the rocks is included in Sethu Rama Rau's memoir on the Geology of Mergui.[20]

### THE MOGOK GEM STONE TRACT.

The large-scale geological mapping of the Mogok stone tract that has been in progress for the last few years and is now nearing completion has considerably increased our knowledge of the geology of this interesting area. The Archæan rocks which occur here have now been divided into a number of stages and mapped separately. This work was begun by J. Coggin Brown and A. K. Banerjee in 1929, and has since been continued by E. L. G. Clegg and L. A. N. Iyer.[21]

The rocks found here include metamorphosed sediments, now appearing as crystalline schists, and a varied suite of intrusive igneous rocks. The metamorphic rocks include quartzites, limestones, calciphyres, and a number of unclassified gneisses. The quartzites, which may be either of replacement or of sedimentary origin, occur in association with calc-gneisses, in some cases passing imperceptibly into calc-granulites. The limestones, calciphyres and calc-gneisses are usually found in association and grade into one another. Although at first sight they appear to occur in discontinuous bands following the general E. 30° N. strike, the mapping indicates that they are probably the remnants of continuous strata reduced to the present isolated fragments by the combined effects of intrusions of syenites and granites, which have eaten their way into them to a large extent, and of the folding and denudation that did the rest. These rocks are of wide-spread occurrence in the tract and show a variety of types containing a number of accessory minerals. Prof. Alam's statement that the limestones and gneisses exposed continuously from Thabeitkyin to Mogok strike north and south is not borne out in general in the area.[22]

The unclassified crystalline rocks, comprising a variety of gneisses and intrusive rocks, appear to be the metamorphosed derivations of argillaceous and arenaceous sediments, intruded along their planes of schistosity by a series of granites, syenites and pegmatites.

The igneous rocks occur in great variety, and the following are the chief types found. The basic and ultrabasic rocks are represented by medium to coarse-grained holocrystalline peridotites. The hornblende-ægirine-nepheline rocks and hornblende-ægirine-scapolite rocks occur in small intrusions or bands usually associated with limestones or, in certain instances, as marginal fringes of syenite intrusions. The syenites were first recognised in the field by Dr. L. L. Fermor and are of a wide distribution, ranging from quartz-syenite to dioritic monzonite. The felspar of the latter are predominantly andesine, and the pyroxene is either augite, ægirine-augite or ægirine. Certain types containing hypersthene approach the intermediate members of the charnockite family of Southern India. The augite and hornblende-granites of the area appear to be a more acid phase of the syenitic magma.

Apart from the description of the various rock formations and their large-scale mapping, which have a value and interest of their own, the recognition of certain points of resemblance between the Burmese Archæan rocks and those of similar composition in Peninsular India constitutes a considerable advance in our knowledge, and we owe it largely to Dr. Fermor's short visit to the Mogok area and his subsequent study of rock specimens collected therefrom. Some of the garnet-sillimanite-gneisses occurring in patches in the Bernardmyo tract have been found by Dr. Fermor to be identical with the khondalite of Peninsular India. Rocks of the Mogok stone tract, according to him,

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18 *Proc. 14th Ind. Sci. Congr.*, 1927, 239.

19 *Rec. Geol. Surv. Ind.*, 1924, **55**, 32.

20 *Mem. Geol. Surv. Ind.*, 1933, **55**.

21 *Rec. Geol. Surv. Ind.*, 1931, **65**, 80-86; *op. cit.*, 1932, **66**, 92-96; *op. cit.*, 1934, **68**, 50-57.

22 *Op. cit.*, 1931, **65**, 80.

exhibit a grade of metamorphism characteristic of the hypomorphic zone (Grubenmann's 'katamorphic zone') and have their analogues in the rocks of the Eastern Ghats of India and Ceylon. The garnetiferous granulites are especially interesting in this respect because they approach in mineral composition the felspathic khondalites of Ceylon. Certain hypersthene-biotite-granulites show a charnockite type of metamorphism, and the cordierite-rocks from the Yebu Chaung recall some of the hybrid rocks described by T. L. Walker and W. H. Collins from the Vizagapatam district of South India.

### THE JADE MINES AREA.

Since A. W. G. Bleek's description of the geology of the Kachin hills in connection with the jadeite, published in 1908,[23] there has been practically no serious geological work done in this region, with the exception of Murray Stuart's traverses across portions of it in the field season 1920-21,[24] until Chhibber commenced the survey of the Jade mines area in 1928.[25] These investigations are still in progress. Systematic mapping has so far been confined to the Jade mines area, in the Kamaing sub-division, but the geology of large tracts of the neighbouring areas is known through traverses to the Chinese frontier and to the Hukawng valley.

The most interesting feature of this region lies in the preservation of the record of several periods of igneous activity dating from post-Permo-Carboniferous up to sub-Recent times. The chief sedimentary formations are the Permo-Carboniferous limestones and the Tertiary rocks. The former overlie unconformably towards the north-east rocks resembling Chaung Magyis (Pre-Cambrian) in lithology, while into the Tertiary rocks are intruded a variety of igneous rocks. There are also crystalline schists which are regarded by Chhibber as ortho-schists. The Permo-Carboniferous are intruded by a batholith of a medium grained granite, represented by a variety of types among which biotite and muscovite-granites predominate. The intrusion is regarded as of Triassic age in common with certain other intrusions in Burma. There are also periodotites and serpentines of probable Upper Cretaceous or Lower Eocene age. Into these latter are intruded the albite-jadeite rocks which are the parent rock of the well-known jade.

The sedimentary Tertiary rocks of the area are now sub-divided as follows:—

Uri boulder conglomerates.
Namting series.
Hkuma series.

The Hkuma series is a thick deposit of a well-bedded sandstone in which occasional intercalations of shaly layers occur. An interesting feature of this series is that the heavy mineral assemblages of these rocks correspond to those of the Barail series (Eocene-Oligocene) of Assam, which corresponds to the Upper Eocene and lower half of the Pegus in Central Burma. Similarly, the Namting series, composed of a considerable thickness of sandstones, shales and conglomerates, has yielded heavy minerals that agree closely with the Tipam series of Assam, corresponding to a portion of the Upper Pegus.

Another interesting feature of this area is the manifestation of igneous activity in post-Tertiary times. This has already been referred to above.

### THE MERGUI ARCHIPELAGO.

During the period under review the geological survey of the accessible parts of the Mergui district was completed, and an account by Sethu Rama Rau was published in 1930.[26] The geology of the northern portion of the archipelago was described by Coggin Brown and A. M. Heron in 1923.[27]

An area in this region that has attracted geological attention in recent years is the Amherst district, where a considerable amount of work has been done. It is impossible, however, to summarise it all within the limits of this article, and a few only of the more important conclusions will be referred to here. Towards the end of 1921 J. W. Gregory[28] and G. de P. Cotter[29] examined the eastern parts of the district in connection with the investigation of the oil shales that occur there, and important knowledge of this hitherto unexplored but geologically very interesting part of Burma was obtained. The oil shales are of late

[23] *Op. cit.*, 1908, **36**, 257.
[24] *Op. cit.*, 1923, **54**, 398.
[25] *Op. cit.*, 1929, **62**, 108-114; *op. cit.*, 1930, **63**, 97-102; *op. cit.*, 1932, **66**, 50-57.
[26] *Mem. Geol. Surv. Ind.*, 1933, **55**.
[27] *Op. cit.*, 1923, **44**.
[28] *Geol. Mag.*, 1923, **60**, 152.
[29] *Rec. Geol. Surv. Ind.*, 1927, **55**, 273.

Tertiary age, and were deposited in basins comparable with those found in the Shan Plateau, Tavoy and Mergui, and indeed far beyond the limits of British India, in Yunnan, Indo-China and Siam. The main Tertiary basin of Pliocene age in which oil shale occurs is the structural valley enclosed by the Dawna range and the Choehko Taung. The Dawna range is built mainly of banded gneisses, schists and gneissose granite, and Cotter's discussion of the age of the gneissose granite constitutes a valuable contribution to our knowledge of the granites of Burma as a whole. In this paper he has gathered together evidence from within Burma and from the neighbouring country of Siam pointing to a Triassic age for some of the Burmese granitic intrusions. Coggin Brown has since brought forward evidence to prove a similar age for the Thaton granite which, he believes, is identical in composition, age and mineral association with the major granite intrusions that stretch from Mergui into the foothills of the Shan Plateau, east of the Kyaukse and Yamethin districts.[30] Most probably these are all of the same age and comparable with the granites of British Malaya, Sumatra, Borneo and the Dutch East Indies.

Another point of much geological interest connected with Cotter's work in this area is his discovery of fossils in the limestones exposed in the Thoungyin river. Although the fossils were found to be in a most disappointing state of preservation, G. H. Tipper, who examined them tentatively, came to the conclusion that they indicated a Triassic age. The attribution of this age to the limestone came rather as a surprise at the time and was accepted only doubtfully, because no limestone of that age had been recorded from the extensive developments of the formation in the surrounding regions of the Shan Plateau, Mergui and Moulmein. Tipper's view, however, was later proved to be perfectly correct by specialists such as Gregory, Julius Pia, Trouth and Weir[31], who worked out the collections a few years ago. It appears possible, therefore, that these limestones represent an upward extension of the Plateau Limestone into the Trias, though hitherto it was considered to have ended with the Permian.

### THE SHAN PLATEAU.

Work by the Geological Survey of India on the Shan Plateau was resumed simultaneously in the Northern and Southern Shan States in 1928. In the Northern States the work has mainly been confined to the extension northwards of T. de la Touche's map of this area published in 1912.[32] In the course of this work several new fossil localities have been discovered, of which the most important is M. R. Sahni's discovery of a unique assemblage of ammonites, gastropods and lamellibranchs in the Plateau limestone at Nam Hkyam.[33] The ammonites include *Xenorpis carbonaria* Waagen, recorded from the Permian of the Salt Range and from Chitral. Another genus is *Nannites*, of which two species have been found, one of which shows affinities with a species recorded from the Otoceras beds of Spiti. The new genus *Hungoritidæ* is the most common ammonite represented. Among the gastropods *Pleurotomaria* and *Naticopsis* are the most dominant. Of the lamellibranchs *Schizodus* is very common.

As regards the Southern Shan States, our knowledge of the geology of this area was very meagre prior to the period under review. As a result of recent work by Coggin Brown and the writer some 2,900 square miles have already been mapped on the scale of one inch to one mile, and in addition extensive traverses have been made running up to the eastern frontier of the Indian Empire. Generally, the geology of this region is essentially the same as that of the Northern Shan States and the only differences are those of minor details. The chief interest of the region is centred on the Ordovician-Silurian succession of which a number of rock facies and horizons are present. Several new fossil localities have been discovered, but, although of very great interest to the science, most of the assemblages have been rather disappointing as regards their correlative value, for in almost all the collections so far examined the majority of forms that are specifically identifiable have turned out to be new to science, except in the case of the graptolite and tentaculite horizons at the bottom and top of the Silurian respectively.

A description of the geology of the country was published recently, and it need not be discussed in detail here.[34] Broadly speaking,

[30] *Op. cit.*, 1928, **60**, 79.
[31] *Op. cit.*, 1930, **63**, 155.
[32] *Mem. Geol. Surv. Ind.*, 1913, **39**.
[33] *Rec. Geol. Surv. Ind.*, 1932, **66**, 97.
[34] *Op. cit.*, 1933, **67**, 135.

the numerous isolated outcrops of Ordovician rocks have been grouped into three divisions based on their fossil contents and lithology. The further sub-division of these groups has been rendered difficult owing to the lateral variations in the lithology and to the sharp differences in the fossil assemblages of different localities. From a number of large collections made by the writer from the Ordovician, F. R. Cowper Reed has been able to find only 33 forms which are in a sufficiently well-preserved state for specific description.[35] Of these 23 are new species. In the Silurian, excepting the graptolite and the tentaculite zones, there are only 4 specifically identifiable forms, and all of them are new. The Ordovician is much better developed here than in the Northern States, the Lower Ordovician, which is not found in the north, having been found in the south with forms allied to those occurring in Annam.

In the Plateau Limestone group the true limestones have hitherto been regarded as forming the upper division and the dolomitic variety the lower division. Recent work in this field, however, has shown that this method of sub-division is not a sound one, and that dolomitisation is not confined to the lower division. A portion of some fossil collections from the 'Upper' Plateau Limestone has recently been described by F. R. Cowper Reed, who has referred them unquestionably to the Anthracolithic system.[36] A remarkable feature of the fauna is the large number of peculiar bryozoans, many of which are new species.

In the next higher formation, namely, the Coal Measures, a flora and fauna, of Middle Jurassic age has been obtained thus indicating them to be contemporaneous with the Namyau beds.[37] It is the writer's view, however, that these extensive deposits include at least a portion of the Napeng beds of Northern Shan States. They are succeeded unconformably by Red Beds, the age of which has been fixed through the discovery by C. S. Fox of a few fossils which indicate them to be equivalent to the Trichinopoly beds of the Coromandel coast, which are Upper (Ariyalur) to Middle (Utatur) Cretaceous in age.[38] This discovery is of unusual interest, as no beds younger than Jurassic were hitherto known from the Shan States, excepting the Pliocene-Pleistocene lake deposits. It is noteworthy that after the deposition of the Permo-Carboniferous limestone all the subsequent deposits were laid down in inland seas and large lake basins. These decreased in extent as time went on, until in Pliocene-Pleistocene times the areas of deposition were restricted to isolated lake basins, remains of which are found far and wide in Eastern Asia, including the Shan States, Yunnan, Siam and French Indo-China.

35 *Pal. Indica* (in the press).

36 *Rec. Geol. Surv. Ind.*, 1933, **67**, 83.

37 See Reference 34.

38 *Rec. Geol. Surv. Ind.*, 1930, **63**, 182.

## Obituary.

### Sir Horace Lamb, F.R.S. (1849-1934).

WE regret to record the death of the eminent applied mathematician Prof. Sir Horace Lamb on December 3, 1934 (born on November 27, 1849). He made valuable contributions to the subject of Hydrodynamics; and his first book *Hydrodynamics* (1870) which was published for the sixth time in 1924 is one of the standard treatises in the subject. In 1884 he was elected Fellow of the Royal Society. He was Professor of Mathematics at Manchester and was recipient of the Copeley Medal of the Royal Society in 1924.

# Letters to the Editor.

## CONTENTS.



## The Theory of Liquids.

IN two recent papers[1] the author has discussed a modification of Edser's theory of liquids which gives equations for the surface tension ($\gamma$) and internal latent heat ($L_i$) as follows:—

$$\gamma = \frac{\mu}{1\cdot 31\,(m-5)\,\sigma^{m+1}} \quad \ldots \quad \ldots \quad (1)$$

$$L_i = (4\cdot 22\times 10^{16})\frac{\mu}{(m-4)\,\sigma^{m-1}} \times \left[1+\frac{T(m-4)\alpha}{3}\right]\text{cals.} \quad \ldots \quad (2)$$

($\mu$=attractive force coefficient; $m$=force index; $\sigma$=the average diameter of the spherical space kept clear around a molecule by its thermal movements at T; $\alpha$=coefficient of thermal expansion). In these equations the effect of the repulsive force, being small, has been neglected.

Although (1) and (2) give results in agreement with observation, they are not altogether satisfactory since the properties of the liquid should be capable of expression in terms of the force constants and T only. It has now been found possible to eliminate $\sigma$ from these expressions for $T_{m.p.}$ by equating the thermal pressure $P_T$ to the internal pressure P. To calculate $P_T$ it is assumed that at and near the melting point diffusion is slow, and that the liquid molecule vibrates for the most part about its mean position.[2] $P_T$ can consequently be put equal to the product of:—

(*a*) the number of molecular centres ($n$) associated with a plane of unit area which is given by the close-packing formula:—

$$n = 2/\sqrt{3}\,\sigma^2 \doteq 1\cdot 15/\sigma^2 \quad \ldots \quad \ldots \quad (3)$$

(*b*) the molecular vibration frequency which is assumed to be equal to the frequency in the solid state at the m.p.[3] and is therefore given by Lindemann's equation[4]:—

$$\gamma = 2\cdot 5\times 10^{12}\left\{\frac{T^{\frac{1}{2}}_{m.p.}}{M^{\frac{1}{2}}\,V^{\frac{1}{3}}_{m.p.}}\right\} \quad \ldots \quad \ldots \quad (4)$$

which as $N\sigma^3 = \sqrt{2}\;V$ .. .. (5)

[1] *Ind. J. Phys.*, 1934, **8**, 521; *Proc. Ind. Acad. Sci.*, 1934, **1**, 105.

[2] *Cf.* Andrade, *Phil. Mag.*, 1934, **17**, 477.

[3] Andrade, *loc. cit.*

[4] *Handb. der Phys.*, 1926, **10**, 52.

can be written

$$\gamma = 4\cdot 25\times 10^{-8}\left\{\frac{T^{\frac{1}{2}}_{m.\mu}}{M^{\frac{1}{2}}\ \sigma_{m.\mu}}\right\} \quad .. \quad (6)$$

($M$ = mass of a molecule)

and ($c$) the change in momentum suffered by a molecule on approach to the plane which is

$$q = 2M\sqrt{kT/M} \quad .. \quad .. \quad (7)$$

We thus have

$$P_i = n\gamma q = 1\cdot 14\times 10^{-15}\left(\frac{T_{m.\mu}}{\sigma^3_{m.\mu}}\right) \quad .. \quad (8)$$

It has already been shown[5] that the internal pressure is given by

$$P = \frac{4\pi\mu}{3\,(m-4)\ \sigma^{m+2}} = \frac{4\cdot 20\ \mu}{(m-4)\ \sigma^{m+2}} \quad .. \quad (9)$$

Combining (8) and (9) we have

$$\sigma^{\ m-1}_{m.\mu} = \frac{3\cdot 68\times 10^{15}\ \mu}{(m-4)\ T_{m.\mu}} \quad .. \quad .. \quad (10)$$

Table I shows $\sigma_{m.\mu}$ (obs.) derived from $d_{m.\mu}$ (obs.) by means of (5), $\sigma_{m.\mu}$ (calc.) from (10) and $d_{m.\mu}$ (calc.) from $\sigma_{m.\mu}$ (calc.) by means of (5). The agreement is fair when it is considered that it is an attempt to calculate the liquid density at the m.p. from the fundamentals $T_{m.\mu}$ (observed) and $\mu$ and $m$ derived from the gaseous state.

TABLE I.

*Calculation of Density at the Melting Point.* (10)

| Substance | $T_{m.\mu}$ | $\mu$ (*Proc. Ind. Acad. Sciences, loc. cit.*) | $m$ | $d_{m.\mu}$ (obs.) | $\sigma_{m.\mu}\times 10^8$ (obs.) (5) | $\sigma_{m.\mu}\times 10^8$ (calc.) (10) | $d_{m.\mu}$ (calc.) (10,5) |
|---|---|---|---|---|---|---|---|
| He .. | 1·0 | $5\cdot 77\times 10^{-60}$ | 7 | 0·146 | 4·02 | 4·38 | 0·11 |
| $H_2$ .. | 13·9 | $2\cdot 33\times 10^{-66}$ | 8 | 0·077 | 3·92 | 3·97 | 0·075 |
| Ne .. | 24·5 | $2\cdot 55\times 10^{-59}$ | 7 | 1·250 | 3·35 | 3·29 | 1·33 |
| Ar .. | 83·1 | $1\cdot 41\times 10^{-65}$ | 8 | 1·419 | 4·02 | 3·97 | 1·46 |
| $N_2$ .. | 63·0 | $2\cdot 02\times 10^{-65}$ | 8 | 0·876 | 4·23 | 4·35 | 0·80 |

Equation (1) when combined with (10) gives

$$\gamma_{m.\mu.} = \frac{(2\cdot 07\times 10^{-16})\ [(m-4)\ T_{m.\mu}]^{\frac{m+1}{m-1}}}{(m-5)\ (3\cdot 68\times 10^{-15}\mu)^{\frac{2}{m-1}}} \quad .. \quad (11)$$

Table II shows the application of (11) using values of $\gamma$ for the lowest temperature observed.

TABLE II.

*Calculation of Surface Tension near the Melting Point.* (11)

| Substance | T | $\gamma$ (obs.) | $\gamma_{m.\mu}$ (calc.) (11) |
|---|---|---|---|
| He | 1.5 | 0.35 | 0.28 |
| $H_2$ | 15.0 | 2.8 | 2.7 |
| Ne | 24.7 | 5.6 | 7.1 |
| Ar | 85.0 | 13.2 | 14.9 |
| $N_2$ | 70.0 | 10.5 | 10.5 |

Equation (2) combined with (10) gives

$$(L_i)_{m.\mu} = 11\cdot 5\ T_{m.\mu}\left[1+\frac{T_{m.\mu}\ (m-4)a}{3}\right] \text{cals.} \quad .. \quad (12)$$

Table III shows the application of (12).

TABLE III.

*Calculation of Internal Latent Heat near the Melting Point.* (12)

| Substance | T | $a$ | ($L_i$ obs.) | $L_i$ calc)(12) |
|---|---|---|---|---|
| He | 1.75 | 0.00 | 18.6 | 20.2 |
| $H_2$ | 15.0 | 0.012 | 189 | 214 |
| Ar | 87.1 | 0.0046 | 1326 | 1530 |
| $N_2$ | 63.1 | 0.0048 | 1330 | 1020 |

It is hoped to publish elsewhere a more rigorous and elaborate development of the ideas underlying this note.

T. S. WHEELER.

Chemical Department,
Royal Institute of Science,
Bombay,
*January, 1935.*

[5] *Loc. cit.*

## A Note on the Method of Determining the Heat of Dissociation from a Study of the Long Wave-length Limit of the Continuous Absorption by Gaseous Molecules.

WHEN a molecule is optically dissociated by a single act of absorption one gets a continuous absorption due to the absorbing substance. In order to obtain the value of the Heat of Dissociation earlier workers in the field used to fix the long wave-length limit of absorption simply from eye observations and this apparently led to discrepancies between the values obtained from optical and thermal data. Quite recently A. K. Datta[1] pointed out that better agreement between the two values may be obtained if the limit is sought from the microphotometric curve of the absorption spectrum. According to Datta the long wave-length limit of absorption is independent of the pressure of the absorbing gas and if curves with percentage of absorption and wave-length as co-ordinates be traced for different pressures they should accordingly cut the wave-length axis at the same point. Applying this idea Datta has determined the value of the Heat of Dissociation for a number of gases (HBr, HI, $N_2O$, etc.). In case of HBr and HI the values obtained by him agree with the calorimetric values without any discrepancy and from this he concludes that the molecules in these cases dissociate into two constituents without any further excitation of either of them. This would mean

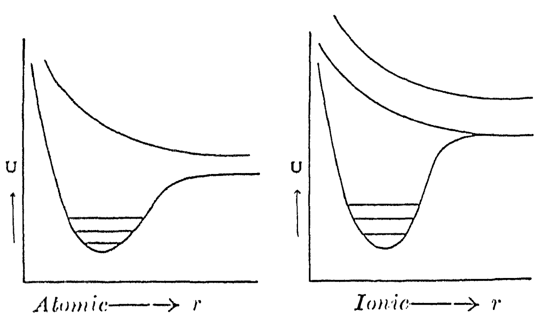


**Fig. 1.**

that these molecules are of ionic linkage thus refuting the commonly accepted idea, first put forward by Franck, that the Hydrogen halides are dipolar molecules with atomic linkage. In this note our object is to point out that the determination of the true long wave-length limit of absorption is not very simple. The following considerations will throw some light on the problem. In case of gases giving only continuous absorption, the potential curves for the molecules in the two states are somewhat as shewn in Fig. 1.

Since in the process of dissociation, the constituents of the molecules after separation move apart with varying kinetic energies, curves showing the relation between the number of atoms or ions and their kinetic energy would become Maxwellian as shewn in Fig. 2. The corresponding curves for the continuous absorption spectrum giving the

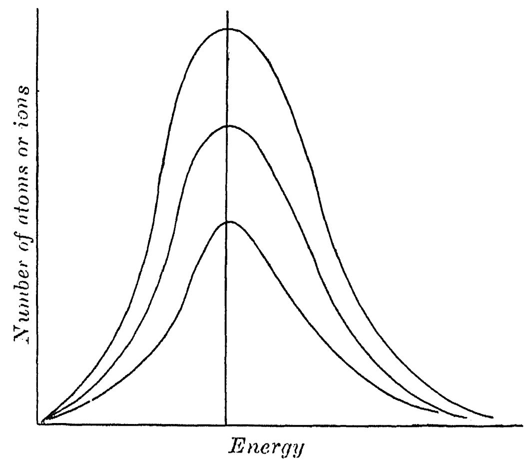


**Fig. 2.**

percentge of absorption and wave-length would accordingly be similar in nature. From the nature of these curves one can presume that there should be increased absorption throughout the absorbed region with increasing number of molecules and had the fundamental vibration frequency of the molecules been very high so that almost all the molecules could be supposed to be in the normal state of vibration, there would be no variation of the long wave-length limit of absorption with pressure. But if the fundamental vibration frequency of the molecules be not very high as is usually the case, then at the ordinary room temperature the number of molecules in the higher vibrational states would perceptibly increase with pressure and this would necessarily cause a shift of the limit of absorption towards longer wave-length. Besides, an increased pressure would enhance the perturbing influence of the neighbouring

[1] *P.R.S.*, 1932, **138**, 84; *Z.f.P.*, 1932, Band **77**, 405.

molecules and may also help the process of dissociation by thermal collision, both of which factors may produce a shift towards longer wave-length. From all these considerations one would rather expect, contrary to Datta's observation, a shift of the long wave-length limit with an increase in pressure. Thus, for an accurate determination of the heat of dissociation one has to take account of all these effects and conduct experiments at very low pressures and temperatures with a fairly large number of molecules in the chamber, *i.e.*, with a long column of the absorbing gas.

The experiments with $N_2O$, HBr and HCl have been repeated by us with an absorbing column of length 25 inches at various pressures and from microphotometric examination of the plates the long wave-length limit of absorption in each case has been found invariably to shift towards longer wave-length with pressure. Calculating the heat of dissociation from the limits obtained at lowest pressures in our experiments it is found that in every case the optical value far exceeds one from thermal measurements. And this is what one would expect as in thermal experiments usually a large quantity of gas at atmospheric pressure is taken so that there are considerable number of molecules at higher vibrational states which would require on an average a much lesser amount of thermal energy for their dissociation as compared to the condition prevailing in the optical experiments at low pressures. In case of HBr and HCl, allowing for the Turner term difference for the halogen atom, a satisfactory agreement is obtained between the two values when photographs are taken at atmospheric pressure. Our observations therefore confirm the original idea put forward by Franck that the hydrogen halides are dipolar molecules with atomic linkages and this is also supported by the fact that there is no record of the second region of selective absorption which one generally finds with molecules of ionic linkages.

A detailed paper will soon be published.

S. DATTA.
B. CHAKROBORTI.

Physical Research Laboratory,
Presidency College,
Calcutta,
*January 18, 1935.*

## Constitution of Water in Solutions.

IN a previous communication,[1] one of us described the results of investigations on the Raman spectra of water in different states and at different temperatures. Therein, it was found that the changes observed in the structure of the Raman band for water under the various conditions of aggregation and temperature could be satisfactorily explained on the hypothesis of molecular association in pure water giving rise to double $(H_2O)_2$ and triple $(H_2O)_3$ molecules in addition to the single molecules $(H_2O)$, the equilibrium between which changes with change of state or of temperature, with the result that their relative proportions are different for the different conditions. From a study of the intensity variations in the structure of the band, it was possible to quantitatively estimate these proportions.

That the influence of dissolved electrolytes on the structure of the Raman water band is similar to that of temperature variation was already pointed out from a preliminary study[2] of the Raman spectra of solutions in water of a few strong electrolytes. But a more systematic study was found necessary before any definite conclusions could be drawn as regards the origin of these changes. Such a study was therefore undertaken with a number of solutes belonging to different types of substances, *viz.*, strong and weak electrolytes and non-electrolytes. The following is a summary of the main changes in the structure of the Raman band of water with varying concentration of different kinds of substances dissolved in it.

1. There is a general sharpening of the band with increasing concentration of the substance dissolved, to whichever class it belonged. This phenomenon is similar to that observed with change of temperature of pure water.

2. With increasing concentration of the solute, there is a shift of the centre of the intensity maximum of the band towards larger values of the Raman frequency, excepting in the case of HCl and chlorides belonging to strong electrolytes, and acetone, which is the only substance pertaining to non-electrolytes that could be studied.

3. The smaller frequency branch of the

[1] I. Ramakrishna Rao, *Nature*, 1933, **132**, 480, and *Proc. Roy. Soc.*, 1934, **145**, 489.

[2] I. Ramakrishna Rao, *Proc. Roy. Soc.*, 1931, **131**, 489.

band attributed to the triple molecules diminishes in intensity in all the cases thus far studied, except for HCl and chlorides, where the change is not so systematic.

4. With strong electrolytes, different substances dissolved to the same molar concentration revealed differences in the intensity distribution of the band. When, however, the same solutions are studied with the water contained in them equalised, these differences diminished to a large extent indicating thereby that the influence of all substances on the structure of the water band is similar. Yet, certain minor differences in the intensity distribution of the band, which are much more than the probable error in the estimation of intensity, persisted, indicating thereby the small but definite influence of each electrolyte by itself.

5. The solution of each electrolyte with the same concentration studied with increasing temperature revealed an enhancement of the changes in the intensity distribution, these variations with temperature in the structure of the band being most conspicuous for those substances which are known, from chemical evidence, to form hydrates.

The above phenomena are explained on the hypothesis that the changes brought about by increasing proportion of solute are mainly due to changes in the constitution of water, arising out of a change in the equilibrium between the single, double and triple molecules. This hypothesis is strongly supported by the observation that solutions of different substances containing the same amount of water give rise to a Raman band which is almost similar in shape and position for all cases. The minor differences which still persisted are attributed to the formation of hydrates, which is different for different substances. The diminution in the intensity of the smaller frequency portion of the band attributed to triple molecules is taken to indicate the relative instability of the triple molecules compared to the other types at higher concentrations of the dissolved substances.

The temperature variation of the structure of the band with the same concentration of a solute is assumed to be also due to an increasing shift in the equilibrium between the three types of water molecules. The conspicuousness of these changes in the case of substances which are known to form hydrates is explained as being due, in addition to change in the water equilibrium, to dehydration or splitting up of the hydrates present in solution into single or double water molecules, or of more complex hydrates into simpler ones.

I. RAMAKRISHNA RAO.
C. SAMBASIVA RAO.

Andhra University,
Waltair,
*January*, 1935.

## Magneto-Resistance Change of Nickel studied with Alternate Currents.

A STUDY of the Magneto-Resistance change of Nickel in Longitudinal Magnetic field, with Direct Currents shows in general a distinct hysteresis effect and also other irregularities.[1] We, however, find a complete disappearance of the hysteresis effect with Alternate Currents. The resistance increases with field showing a saturation value as in the case of Direct Currents; but while in the case of Direct Currents the decrease of resistance with decreasing field shows generally a hysteresis effect and occasionally the reverse of it (*i.e.*, the Magneto-Resistance curve for decreasing field going below that for increasing field), no such effect is however noticed by us in the case of Alternate Currents. We also find that in this case each half cycle is exactly the image of the other, whereas in the case of Direct Currents the half cycles are generally dissimilar unless the sample is demagnetised every time before a resistance measurement is done.[2] The percentage change of resistance, however, when the saturation is reached is of the same order as previously measured with Direct Currents by other investigators including ourselves.

It is important to note here that a similar disappearance of the hysteresis loop in Magneto-Resistance curve has been previously observed even with Direct Currents in the case of electrolytic iron[3] and of Nickel at high temperature.[4]

Work is proceeding to study the problem in all its aspects, and details will be published shortly.

M. M. SEN GUPTA.
H. MOHANTY.
S. SHARAN.

Department of Physics,
Ravenshaw College, Cuttack,
*January*, 1935.

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[1] M. M. Sen Gupta and M. S. Alam, *Ind. Jour. Physics*, **8**, P. I, p. 9.
[2] O. Stierstadt, *Physical Rev.*, 1931, **37**, 1356.
[3] O. Stierstadt, *Zeits. f. Physik*, 1930, **65**, 575.
[4] W. Gerlach, *Zeits. f. Physik*, 1930, **59**, 847; *Ann. d. Physik*, 1930, **6**, 772.

## The Constitution of Vasicin.

In an earlier note[1] we have reported that 3-allyl 4-oxyquinazoline, on reduction with sodium in amyl alcohol, gave a base which was not identical with the similar reduction product of vasicin described by Spath *et al.* It was on this ground that we advocated the rejection of the Spath-Nikawitz formula for vasicin.

Again, we drew attention to the fact that 3-allyl 3 : 4-dihydrobenz 1 : 3-diazine of Paal and Stollberg was not identical with desoxyvasicin.[2] We, therefore, welcome the publication of a recent paper by Hanford, Liang and Adams[3] in which both of these statements have been confirmed by new experiments and also by repetition of our own. New evidence against the Spath formula has also been found by showing that 3-allyl 1 : 2 : 3 : 4-tetrahydroquinazoline and dihydro desoxyvasicin are not identical.

Hence the question arises as to what is the correct structure of vasicin.

Hanford *et al* have expressed the opinion that the side chain is in the form of a third fused ring and have proposed two possible structures of which they have expressed preference for one. We would recall that we have already given one of these formulæ as a possibility.[4] Owing to quadrilateral publication from Lahore, Vienna, Oxford and Illinois, confusion with respect to the present knowledge of the chemistry of vasicin has arisen. The position may be summarised as follows :

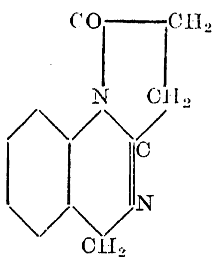
We established that on oxidation vasicin gives 4-oxyquinazoline thus leaving three of its carbon atoms unaccounted for. Later Spath *et al* observed the formation of 4-oxyquinazoline 3-acetic acid on gentler oxidation and postulated an allyl group attached to the nitrogen atom in a reduced 4-oxyquinazoline.

The presence of the allyl grouping has never been definitely established[5] and the non-reduction of vasicin by catalytic means has been duly stressed. The difficulty in assigning a constitution to vasicin arises from the fact that it has $\alpha_D = 0$, therefore a formula must be advanced without an asymmetric atom. The production of 4-oxyquinazoline by oxidation is no proof of the pre-existence of the oxygen atom in this position in vasicin. We have emphasised this point in several previous publications.

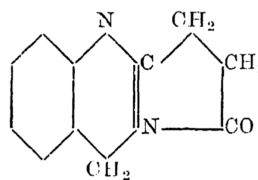
It is on this slender experimental evidence that we have to grope for the constitution of vasicin. Naturally, to guess the correct formula one would have to eliminate one alternative after the other. Thus those arriving later in the field will have a natural advantage over the earlier workers. We had clearly stated our position in a previous paper[6] and are still working on the problem of the constitution of vasicin and have covered much ground since last August. However, in view of the publication of Hanford *et al*, we desire to place on record the salient facts which we have established.

We have reduced electrolytically substance (I) and found its picronolate to be different from the picronolate of the electrolytic reduction product of vasicin. This disposes of one of the alternatives suggested by the American authors. We have also found that the picronolates of the electrolytic reduction products of 2-propyl 4-oxyquinazoline and 3-allyl 4-oxyquinazoline are different from reduced vasicin picronolate.

We have also synthesised the substance (II),




(I)




(II)

and we are engaged in reducing it electrolytically in order to compare its picronolate with that of reduced vasicin. The result should show how far the cyclic structure, at present indicated, is justified. The full experimental details will be published elsewhere.

We trust that this note on our future programme will save duplication of work by other investigators, and hope that we will be able to complete a problem which has

1 Narang and Ray, *Curr. Sci.*, 1934, **2**, 388.

2 *Cf. Chemistry and Industry*, 1934, **53**, 698.

3 *J. Amer. Chem. Soc.*, 1934, **56**, 2780.

4 *Cf.* Narang and Ray, *Chem. and Ind.*, 1934, **53**, 698.

5 *Cf.* Ghosh, Krishna, Narang and Ray, *J.C.S.*, 1932, 2740.

6 *Chemistry and Industry, loc. cit.*

received our attention for the best part of three years without being anticipated.

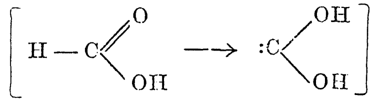
J. N. RAY.
K. S. NARANG.
H. R. JUNEJA.

The University,
Lahore,
*January*, 1935.

### Constitution of Formic Acid and Formates.

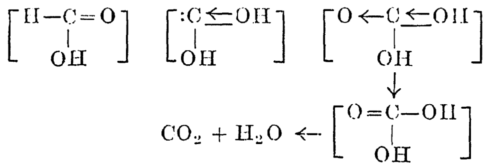
IN order to explain the exceptional behaviour of Formic acid as compared with its homologues the suggestion has been made[1] that in it the ionisable hydrogen is not the hydrogen of the hydroxyl group as in the case of the other fatty acids but the hydrogen attached to the carbon atom. If this could be proved, Formic acid would become not only exceptional among the fatty acids, but would hold a unique position among all organic compounds. A number of substances are known having $CH_2$ or CH groups the hydrogen atoms of which are reactive. But none of these atoms ionises sufficiently to render the compounds acids. HCN could be mentioned in this connection. It is, however, a very weak acid, weaker than carbonic acid and even here probabilities are in favour of attributing the acid character to the isomeric form HNC. Consequently the new constitution for Formic acid cannot be accepted as explaining its exceptionally strong acid character. There is also the difficulty of explaining why the hydrogen of the carboxyl group fails to ionise under conditions in which it invariably ionises in similar compounds. Further it should be noted that although Formic acid possesses certain properties not in common with its homologues it certainly exhibits several similarities.

In my opinion the exceptional properties of Formic acid are due to the fact that in it the carboxyl group is linked to a hydrogen atom whereas in its homologues the carboxyl is linked to alkyl groups and that in the course of certain of its reactions Formic acid is capable of undergoing isomeric change into dihydroxy methylene.

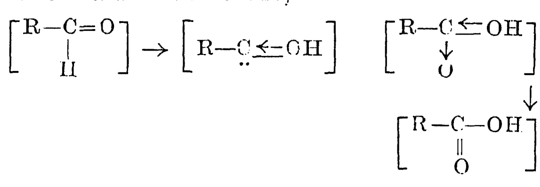


In acetic and propionic acids the alkyl groups act as electron sources inhibiting the removal of a proton from the carboxyl and thus making the substances weaker acids just as halogens and nitro groups act as electron sinks increasing ionisation of the hydrogen and thereby enhancing the strength of the acid. Between the members of the homologous series up to Formic acid there exists only the smaller differences between alkyl groups whereas between acetic and formic acids there is a bigger jump when alkyl groups disappear altogether and a hydrogen atom is present instead.

Though the ionisable hydrogen in formic acid is the one belonging to the carboxyl group there are indications that the other hydrogen atom also is reactive and the compound is capable of assuming the isomeric form given above. In this connection may be mentioned (1) the claim of Scheibler and his co-workers of having produced compounds of the constitution $C(OC_2H_5)_2$ and $C(ONa).(OC_2H_5)$;[2] (2) the behaviour of ethyl formate as an enolisable substance,[3] and (3) the analogous case of hydrocyanic acid which is known to react in two isomeric forms. On this assumption of the dihydroxy methylene form the preparation of Formic acid and all its exceptional properties find easy explanation. Its ready oxidisability can be represented as below:



The oxidation of aldehydes which takes place best in alkaline solutions seems to follow a similar course,



Formaldehyde has been known to exhibit definite though small ionisation of hydrogen.

[1] Sir P. C. Ray, *Nature*, **133**, 646; P. B. Sarkar, *Indian Science Congress Abstracts*, Chemistry Section, 1935.

[2] *Ber.*, 1926, 1031; 1927, 554; 1934, 312.

[3] *Ber.*, 1934, 314.

The old idea of attributing the exceptional properties of Formic acid to the existence in it of an aldehyde group appears, therefore, to be correct.

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Andhra University,
Waltair,
*February 5, 1935.*

## The Effect of the Substituents on the Formation of the Chloralides of Salicylic Acid and Its Derivatives.

WALLACH[1] prepared the chloralide of salicylic acid by heating the components in sealed tube. In contrast to the aliphatic α-hydroxy acids which form the chloralides very easily, Wallach found that most of the salicylic acid was recovered unchanged. After a very tedious separation, he reported to have got a small quantity of the chloralide which he did not investigate further.

During the course of their work on chloralides, Shah and Alimchandani[2] tried to prepare the salicylic acid chloralide. The condensation was tried under varying conditions in presence of different condensing agents with no advantage. There was no condensation in presence of glacial acetic acid or concentrated HCl, while sulphuric acid gave a product from which no crystalline product could be separated.[3]

The present authors, because it appeared to them that this complexity was due to –OH group in the salicylic acid, studied the condensation with the methyl ether of salicylic acid. The main product of this reaction which has now been thoroughly investigated is 4-methoxy-5-carboxy-1-α-hydroxy-βββ-trichloroethyl benzene, the chloral attaching in *para* position to the --OMe group.[4] This condensation, however, excludes the possibility of the chloralide ring formation because the –OH group has been protected.

The possibility that the reactivity of the free salicylic acid referred to above may perhaps be moderated by the presence of the suitable substituents in the salicylic acid nucleus was next investigated with a view to get the chloralide of the substituted salicylic acid derivative and then eliminating the substituent to get the chloralide of the salicylic acid itself. For this purpose, we first studied the condensation of chloral with 3-nitro and 5-nitro salicylic acids, (1) by heating the components in sealed tube and (2) in presence of $H_2SO_4$. It is interesting to note that although the effect of all the substituents individually and collectively might be expected favourable to the introduction of the chloral molecule in the vacant positions (*ortho* or *para* to the –OH group) or for forming the chloralide ring, the acids were recovered unchanged. A similar experience is recorded by Meldrum and Hirve in case of 3-nitro salicylic acid which resisted all their attempts to sulphonate.[5] The methyl ethers of these nitro salicylic acids behaved similarly towards chloral.

The effect of other substituents like Br, $SO_3H$ and $NH_2$ in salicylic acid is being investigated and the detailed results will be published elsewhere.

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S. G. DEO.

Karnatak College,
Dharwar,
*January 26, 1935.*

[1] *Annalen*, 1878, **193**, 1-61.

[2] *J. Indian Chem. Soc.*, 1934, **11**, 545.

[3] Chattaway and Calvet, *J.C.S.*, 1928, 1090.

[4] Meldrum and Hurry, *J. Indian Chem. Soc.*, 1934, **11**, 535.

[5] *J. Indian Chem. Soc.*, 1930, **7**, 887.

## The "Non-Protein" Nitrogen of Pulses.

DURING the preparation of globulins and albumins from pulses, there exists, in the saline extract, a nitrogenous fraction, non-protein in character, diffusible through dialysing membranes, non-precipitable by saturation with salts, non-coagulable by heat and indifferent to drastic protein precipitants like trichloracetic acid. The extensive work carried out on the proteins of pulses relates chiefly to the globulins which occur in them in a predominant proportion and the methods usually employed for their isolation render a recovery of the non-protein nitrogenous fraction, extremely difficult and cumbersome. Further, there are, at the moment, no systematic methods for investigating a mixture of the complexity represented by this fraction. It is therefore not surprising that this valuable fraction has not received any adequate attention at the hands of the several investigators.

The amount of this fraction which is thus lost, varies from 10 to 55 per cent. of the nitrogen extractable by the saline solution depending upon (1) the nature of the pulse under investigation, and (2) the method adopted for the estimation of the non-protein fraction. It will be observed from Table I that particularly large quantities, 20-55 per cent., are lost during (1) dialysis, and (2) saturation with ammonium sulphate, which constitute the two well-known methods generally adopted for the preparation of proteins.

TABLE I.

| | Percentage of Nitrogen lost during isolation of proteins by | | | | |
|---|---|---|---|---|---|
| | Ultrafiltration | Trichloracetic Acid | Heat Coagulation | Dialysis | Saturation with Ammonium Sulphate |
| *Cajanus indicus* | 14.3 | 23.5 | 45.6 | 25.7 | 23.6 |
| *Lens esculenta* | 26.1 | 29.3 | 46.2 | 52.1 | 43.6 |
| *Phaseolus aconitifolius* | 27.6 | 29.5 | 40.5 | 55.3 | 43.3 |
| *Dolichos biflorus* | 20.7 | 29.2 | 55.1 | 55.2 | 40.7 |
| *Cicer arietinum* | 12.1 | 19.1 | .. | 19.6 | 23.1 |
| *Vigna Caliang* | 11.9 | 11.5 | 23.6 | 25.1 | 39.8 |
| *Dolichos Lablab* | 16.0 | 11.9 | 36.0 | .. | 26.1 |

The average complexity of the non-protein fraction, as determined by the ratio of the total to amino nitrogen, is given in Table II, which reveals that the non-protein fractions, particularly those obtained by ultrafiltration and trichloracetic acid precipitation,

TABLE II.

*Average Complexity of the Crude Saline Extracts and the "non-Protein" Fractions.*

| | Crude Extract | Ultra-filtrate | Trichloracetic Acid | Heat Coagulation |
|---|---|---|---|---|
| *Cajanus indicus* .. | 6.4 | 2.0 | 2.0 | 4.0 |
| *Lens esculenta* .. | 7.1 | 2.5 | 2.9 | 4.8 |
| *P. aconitifolius* .. | 7.0 | 2.0 | 2.7 | 2.8 |
| *Dolichos biflorus* .. | 7.4 | 2.6 | 2.6 | 4.4 |
| *Cicer arietinum* .. | 10.6 | 3.8 | 3.5 | 6.3 |
| *Vigna Caliang* .. | 10.4 | 2.3 | 2.1 | 3.1 |
| *Dolichos Lablab* .. | 11.2 | 2.9 | 2.6 | 6.8 |

contain a high proportion of very simple peptides. The fraction obtained by heat coagulation which represents the nearest approach to the conditions of culinary practice, corresponds to the portion generally administered to invalids and children. It is particularly interesting to observe that the average complexity of the fractions in general run parallel to the recognised ease of their digestibilities. The non-protein fraction of *P. aconitifolius*, for instance, has the lowest ratio of 2·8 in the heat coagulation series, a fact which is in harmony with the reputation which the pulse enjoys as a very easily digestible and nutritious source of nitrogen during convalescence.

The non-protein fraction of these pulses, therefore, merits a detailed investigation not only with regard to their amino acid make up but also with regard to its possible rôle in influencing the peptisability, increasing the digestibility and supplementing the possible deficiency of the associated protein. An attempt in this direction with regard to the well-known Indian pulses is now being made.

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*February 7, 1935.*

## Synthesis of Vitamin C by Human Infants.

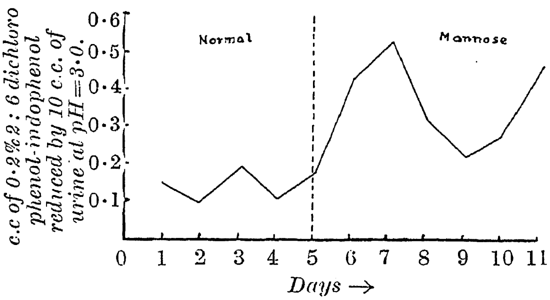
THE observations detailed here were undertaken with a view to see how far there was correspondence in the metabolism in plants and animals in synthesising ascorbic acid from carbohydrates.

Roy[1] has shown that seedlings of pea have the property of converting Mannose to Ascorbic acid to an appreciable extent. Guha and Ghosh[2] have recently found that "in vitro" the isolated kidney, liver and spleen of rats in Ringer solution converts Mannose into "Vitamin C" to a significant extent. Somewhat earlier, Ursula Saunders *et al*[3] showed that like "rats and birds, human infants have the property of synthesising Vitamin C and that this property is maximum at an age of nearly 5 months" diminishing and ultimately disappearing after 14 months.

The preliminary observations here described were carried out with a healthy boy of 5-6 months old (author's nephew), entirely breast-fed. The urine passed between the hours of 5 to 11 a.m. was collected

[1] S. N. Roy, *Biochem. J.*, 1934, **28**, 999.
[2] B. C. Guha and A. R. Ghosh, *Nature*, 1934, **134**, 739.
[3] Ursula Saunders *et al*, *Nature*, 1934, **134**, 142.

over sulphuric acid and examined according to Tillman's Technique as modified by Birch, Harris and Roy.[4] The morning urine only was tested following the experience of Johnson and Zilva.[5] As the urine was always almost colourless, the precautions during titration suggested by Emmerie and Eckelen[6] were not necessary. For the first five days the normal urine of the child was daily examined. Then for the next succeeding days the child was given a daily dose of 1 gram Mannose with the mother's milk at 7 p.m. The results observed and graphically represented below are very interesting. The ascorbic acid content under Mannose feeding




showed a considerable amount of increase. A detailed examination of the above results with other details and discussions will be published in the *Transactions of the Bose Research Institute*.

HIRENDRA NATH BANERJEE.

Bose Research Institute,
Calcutta,
*January 28, 1935.*

## Starch Accumulation in Stenosised Cotton Plants.

STENOSIS of cotton plants, a malady which has attracted serious attention in recent years, is characterised by a diminution in the size of the leaves. Microscopic examination of sections of tissues revealed that starch had accumulated in the leaves, the vascular bundles of petioles, stems and roots of stenosised plants, while sections of not only the healthy plants but also those of the healthy branches arising from diseased plants did not show any accumulated starch. The starch content of the leaves was estimated by Allihn's method and the results (on dry weight basis) obtained are given below:

TABLE I.

| Material (Leaves) | Per cent. Starch on dry weight basis | | | |
|---|---|---|---|---|
| | Preserved in alcohol | Fresh | Ratoon crop preserved in alcohol | Plant partially stenosised |
| Healthy | 13·25 | 11·00 | 11·25 | 12·25 |
| Stenosised | 18·30 | 17·50 | 15·75 | 16·75 |

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G. H. DESAI.

Research Laboratory,
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*October, 1934.*

## Production of Dwarf Amphidiploid Tobacco Plants by Hybridisation.

IN crossing *Nicotiana rustica* var. *humilis* ($2n=48$) with *N. glauca* ($2n=24$) the pollen-tubes of *glauca* reach the ovary of *rustica* and fertilisation occurs but the embryos die in a very early stage of embryonic development. In crossing *N. rustica* var. *texana* ($2n=48$) with *N. glauca*, $F_1$-hybrid (*N. rustica* var. *texana* × *N. glauca*) was produced. $F_1$-hybrid developed normally and reached a height of about 150 cm. The same size had the paternal plants growing at the same environmental conditions, while the maternal plant had a size of about 80 cm.

This case shows clearly that the production of species hybrids often depends on the genotype, *i.e.*, on the variety of the species used in the interspecific cross, a phenomenon noted before in *Nicotiana* too (Kostoff, 1930).[1]

The reduction division in $F_1$ was irregular. Restitution nuclei and dyads were occasionally observed. The hybrid formed about 5–12% viable pollen grains of various size, but it was self-sterile. We selfed flowers of the hybrids and then pollinated the same flowers with pollen from *N. rustica* var. *humilis* or var. *texana*.

[4] Birch, Harris and Roy, *Biochem. J.*, 1933, **27**, 590.

[5] Johnson and Zilva, *Biochem J.*, 1934, **28**, 1393.

[6] Emmerie and Eckelen, *Biochem. J.*, 1934, **28**, 1153.

[1] Kostoff, Dontcho, *Genetica*, 1930, **12**, 33-139.

From such crosses seeds were produced from which plants were raised. Amongst these plants we found triploids (2 *rustica* genomes + 1 *glauca* = 60 chromosomes), two tetraploids (amphidiploids) with 72 chromosomes, one pentaploid plant with 96 chromosomes (3 *rustica* genomes + 2 *glauca* genomes), and chromosomal aberrants with chromosome number grading from 48 to 70. The triploids were many more (about 40) than the chromosomal aberrants (about 15).

The amphidiploids were *dwarfs*. One reached a size of about 12 cm. and formed a flower. The latter dropped before setting seeds. The other amphidiploid grew taller and reached a size of about 73 cm., *i.e.*, smaller than the parental plants, $F_1$-hybrid and the triploids. It flowered and set seeds after selfing. All of the plants grew in the green house at about the same environmental conditions. Special care was taken for the improvement of the growth of the amphidiploid that was about 12 cms. tall, but without any results.

**Fig. 1.**

A somatic plate from an amphidiploid *rustica-glauca* plant.

The production of dwarf amphidiploids with lower vitality than the parental species, the $F_1$-hybrid, the triploids, and the majority of the chromosomal aberrants indicates that the amphidiploids, or generally speaking, the tetraploids (*vide* also Kostoff and Kendall, 1934)[2] are not always "giants" and that polyploidy is a limited factor in evolution.

A too great increase of the chromosome number lowers the vitality of the organism. In reality we know very few plants in nature with 200 chromosomes or more than that, and these plants are not "giants" in comparison to the other species of the same genus having smaller chromosome numbers.

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Academy of Sciences of U.S.S.R,
*January, 1935.*

[2] Kostoff, Dontcho and Kendall, James, *Gartenbauwissenschaft*, 1934, **9**, 20-44.

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## The Life History of *Utricularia coerulea* L.

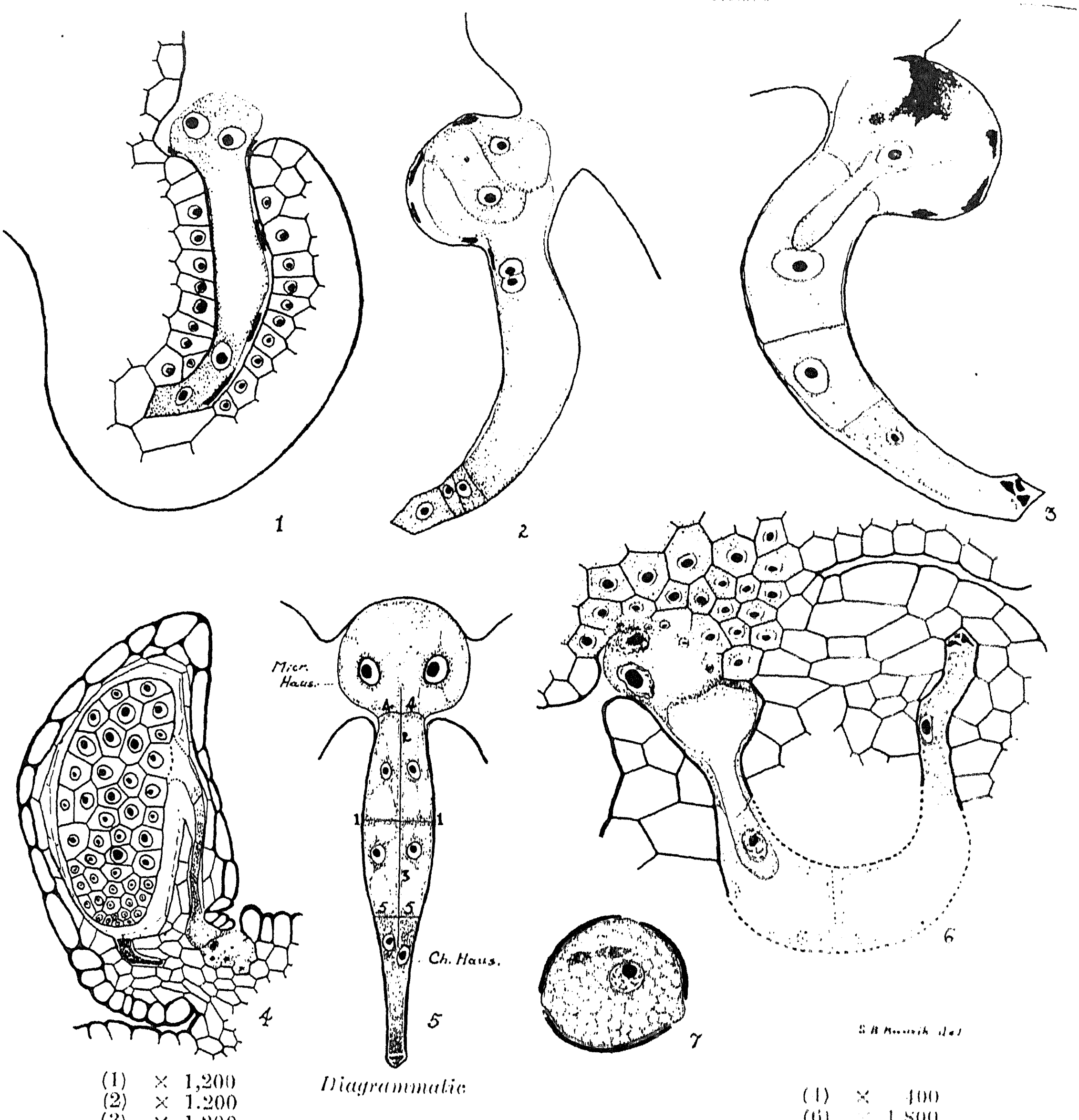
OF the few morphological studies in the Lentibulariaceæ, the work of Wylie and Yocom[1] on the formation of endosperm in *Utricularia vulgaris* is the latest. The following is a brief account of the life-history of *Utricularia coerulea*. The larger paper will be published shortly.

The ovary has an indefinite number of ovules, each with a single massive integument. A single archesporial cell functions directly as the megaspore mother cell and gives rise to the linear tetrad of megaspores, the lowest of which develops into the eight-nucleate embryo sac. The nucellus disorganises very early. The embryo sac begins to grow out of the micropyle (Fig. 1) at the four-nucleate stage, so that finally the egg apparatus lies outside the ovule where the pollen tube meets it. The micropylar end of the sac, which thus lies exposed is in contact with a rich placental nutritive tissue on which it feeds. The antipodal end is tapering and lies in the midst of a chalazal nutritive zone (Fig. 2).

Syngamy is effected in the resting condition of both the egg and the male nucleus, the chromatin of the latter staining more deeply. Variations in triple fusion are observed :—(*a*) the polar nuclei fusing first and then the second male nucleus entering into the union, (*b*) the second male nucleus fusing first with one of the two polars, and (*c*) the two polar nuclei and the male nucleus fusing simultaneously. In all cases the two polar nuclei do not fuse but merely lie close together until the second male nucleus has come in contact with them, and not immediately on the entry of the pollen tube as stated by Wylie and Yocom.

The fertilised egg which is externally situated puts forth a slender tubular growth which entering the micropyle, pierces

[1] Wylie, R. B., and Yocom, A. E. (1923), "The Endosperm of Utricularia,' (Abstracted from Karl Schnarf's *Embryologie der Angiospermen*, Berlin, 1929.)




(1) × 1,200
(2) × 1.200
(3) × 1,200

*Diagrammatic*

(4) × 400
(6) × 1,800
(7) × 900

**Figs. 1-7.**

through the compact cells of the already formed endosperm (Fig. 3). Its nucleus migrates down this tube and the first division takes place at its tip. The formation of a tube from the fertilised egg has not been till now reported in any case. The fully formed embryo which completely fills the cavity of the seed is undifferentiated except for a small group of cells at the apex, the "Vegetationsspitze" of Merz[2] (Fig. 4).

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[2] Merz, M., "Untersuchengen uber die Samenentwicklung der Utricularien," *Flora*, 1897, **84**, 69-87.

On the division of the primary endosperm nucleus, the embryo sac is first divided by a transverse wall into two chambers, both of which contribute equally to the formation of endosperm. This is said to be of rare occurrence and is thus an important departure from the mode of endosperm formation in *Utricularia vulgaris* which conforms to the Scrophulariaceous type as stated by Wylie and Yocom. The micropylar and chalazal haustoria are differentiated only after the fourth and the fifth divisions respectively (Fig. 5—the numbers indicate the sequence of walls). The haustoria are

binucleate and take an active part in the absorption of nutrition from the placental and chalazal nutritive tissues. After their function is over their nuclei break down (Fig. 6).

The cytology of the pollen mother cells has been worked out in detail. The mode of chromosome pairing is parasynaptic. The haploid number of chromosomes is determined to be twenty. The tetrad of pollen grains is formed by the quadripartition furrows along with vacuolization. The pollen grains at the time of shedding have each a large tube nucleus and two spindle-shaped male cells (Fig. 7).

Grateful acknowledgment is made to Dr. M. A. Sampathkumaran for direction.

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*January, 1935.*

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### Proliferation of the Cone in a Species of *Selaginella* from Garhwal.

THE plants were collected in August 1931 by the late Professor S. R. Kashyap from the Alaknanda Valley in Garhwal at a height of about 8,000 ft. above the sea-level, and were kindly handed over to me for investigation. A preliminary paper on the subject was read by me at the Botany Section of the Nineteenth Session of the Indian Science Congress held at Bangalore in January 1932.[1]

The plants belong to the sub-genus Stachygynandrum of *Selaginella*[2] as they possess uniform bracts and ordinary leaves of two kinds and spreading in two planes, those of the upper plane being smaller and more ascending. They show characters closely resembling those of *S. Caulescens* sp. The stem is on the average about 9 inches long, erect and unbranched in the lower half, with spaced adpressed leaves. The spikes are square and the bracts are ovate, cuspidate.

In many cases the homophyllous cone continues to grow and may produce one or two cones in continuation (Fig. 1 *a*, *b* and Fig. 2 *c*) or branch out into two cones at the tip (Fig. 2 *d*, *e*). All these cones have a sterile region at the base, where in many cases the leaves show a clear tendency to revert to the dorsi-ventral arrangement characteristic of the vegetative region, but have not been seen to acquire fully the dorsi-ventral arrangement typical of the purely sterile parts.

In *Selaginella*, as a rule, the cone is

[1] *Proceedings of the Indian Science Congress*, 19th Session, p. 308.

[2] Baker's *Handbook of the Fern Allies*, London, 1887, p. 32.

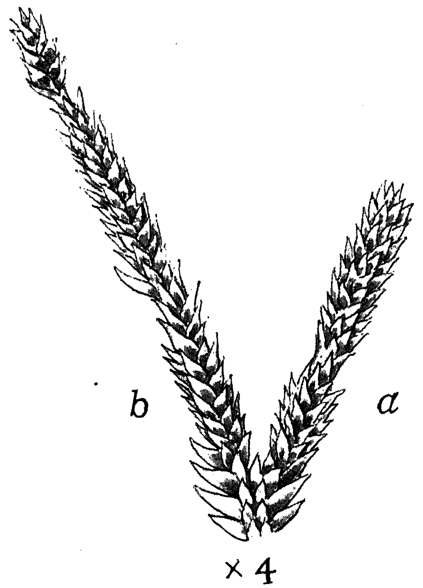


**Fig. 1.**

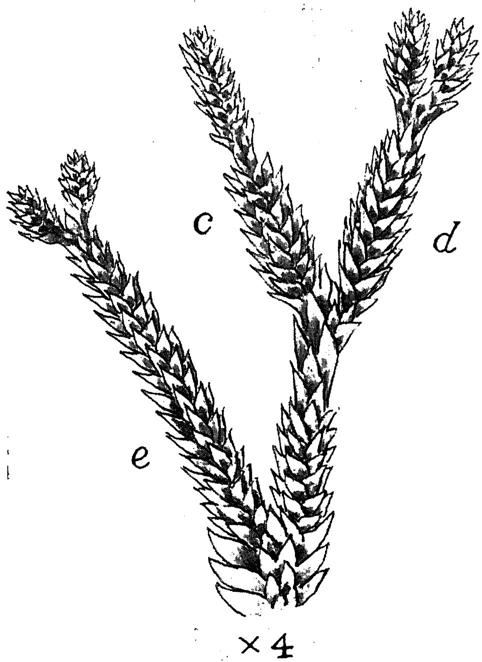


**Fig. 2.**

terminal and unbranched. Miss Mitchell,[3] however, has described the following four variations from the normal type: (1) In *S. patula* and *S. cuspidata* "beyond the fertile homophyllous cone the axis continues to grow vegetatively reverting to the dorsi-ventral structure characteristic of the ordinary stem". (2) In an un-named species, from India, probably *S. pennata*, the same phenomenon was observed "save that abortive sporangia were produced in the axils of the vegetative leaves following the tip of the cone, illustrating the gradual transition between the purely sterile and entirely fertile regions." (3) In *S. erythropus* a second cone was produced on a fertile branch after an intervening sterile region entirely devoid of any vestiges of sporangia, in other words, two definitely fertile regions occurred in the same branch. (4) In *S. oregana* the strobilus is genuinely branched. There is a region with entirely aborted sporangia at the base of the branches, but the leaves of this region retain the external form of the sporophylls.

A genuinely branched strobilus has been described by the writer[4] in *S. pallidissima*, in which sporangia are found in the whole of the branched structure, but are, as a rule, confined to the axils of the sporophylls of the lower plane only, the upper sporophylls being generally sterile.

The nature of the proliferation of the cone in the species from Garhwal described above does not fully correspond with that of any of the cases already recorded, but seems to combine the last two abnormalities mentioned by Miss Mitchell. Fig. 1 shows 2 and 3 definitely fertile regions occurring on the same branch, resembling the case of *S. erythropus*, while Fig. 2 shows genuinely branched strobili like those of *S. oregana*, with the slight difference that the leaves at the base of each fertile portion are sterile and show a tendency to revert to the arrangement characteristic of the vegetative region.

In these proliferated cones there is a tendency of alternation of sterile and fertile zones, which "suggests the condition normally occurring in the more primitive Lycopodiaceæ".

S. L. Ghose.

Botany Department,
Government College, Lahore,
*January 21, 1935.*

[3] *Annals of Botany*, 1910, **24**, 21-25.
[4] *Journal of Bombay Natural History Society*, 1917, **25**, 281-289.

## The Somatic Chromosomes of *Urginea indica* Kunth.

The salient points of a paper to be published elsewhere are set forth in this note which deals essentially with the chromosome morphology of *Urginea indica*, a common bulbous plant of the east coast of South India. The somatic number is twenty; all the chromosomes are not of equal size and they exhibit "somatic pairing" (Fig. 1). The complement is resolved into four types on the basis of the size of the chromosomes (Fig. 2).

Details of mitosis which have been worked, show that the early prophase chromatin threads are double and the spiral nature of the chromatids is distinctly visible. The metaphase chromosomes which result from the linear contraction of the chromatids of the prophase threads are made up of two cylindrical halves (chromatids) which are sometimes seen to be hollow, probably an artefact. In early metaphase chromosomes the two limbs are more or less separate except at the region of the constriction while in the full metaphase, they are very closely united. The separation commences at the constriction; hence they are attachment-constrictions. The anaphase chromosomes being merely the separated chromatids of the metaphase ones are only single cylindrical structures which sometimes on account of their hollow nature simulate a dual structure. The two edges of the cylinder present the appearance of two parallel threads with a less deeply staining intervening space. The writer is not able to support the chromonema theory which endows the anaphase chromosome with a dual structure and the metaphase one with a quadripartite structure, the chromonemata being supposed to be embedded in an achromatic matrix. The observations recorded herein do not allow of such an assumption.

The characteristic nucleolar behaviour seems to be fragmentation prior to disintegration. It is single to start with, always surrounded by a "halo" and by a process of "budding" separates into a number of bits which finally disappear. Frequently the nucleoli are extruded into the cytoplasm and occasionally they persist upto the late metaphase. These taken together indicate the absence of any direct relation between the nucleolus and the chromatin material of the chromosomes. If anything, it can be considered to be a dehydrated bit of cytoplasm.


Fig. 1.

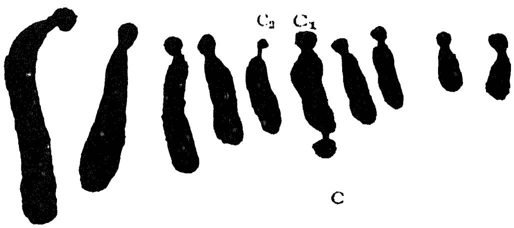


Fig. 2.

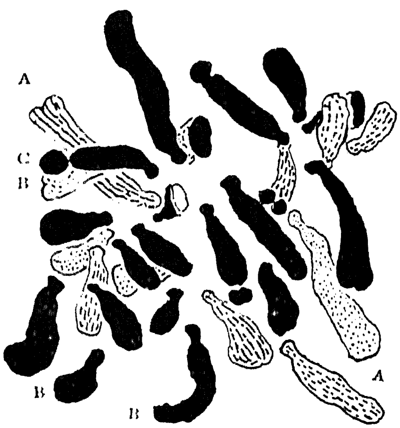


Fig. 3.

A. A pair of long chromosomes with subterminal constriction.

B. Two pairs of chromosomes slightly shorter than A and possessing also subterminal constriction.

D. Two pairs of very short chromosomes with prominent subterminal constriction.

C. Five pairs, intermediate in size between B and D. Of these one pair $C_1$ shows a secondary constriction at its distal end in the nature of a satellite. In another $C_2$ the segment beyond the constriction is minute.

Triploidy has also been observed; the chromosomes occur in sets of threes in the complement (Fig. 3).

T. S. RAGHAVAN.

Annamalai University,
Annamalainagar,
*January 20, 1935.*

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## Polyembryony in *Murraya kœnigi* (Spreng).

THE phenomenon of polyembryony has been observed till now as far as information could be gathered in only two genera of the family *Rutaceæ*. They are Citrus, and Xanthoxylon. In both these cases the additional embryos take their origin from the nucellus. In Xanthoxylon,[1,2] fertilization does not take place. In Citrus,[3] fertilization has been observed and the normal embryo also develops. While working last year on the Cytology and Morphology of some *Rutaceæ* it was noticed that a third genus of this family, *Murraya*, exhibited this interesting feature.

The embryo sac of *Murraya kœnigi* is of the normal 8-nucleate type. Fertilization has been observed. The egg divides late by which time the endosperm will be in the free nuclear state. It can be seen now that most of the cells of the nucellus at the micropylar region stain dark. They are all potentially embryogenous and most of them undergo further development. But only those embryos that lie on or very near the border of the embryo sac cavity project into it and continue to develop further (Figs. 1 & 2, from sections of the same ovule and Fig. 3). Thus numerous nucellar embryos develop side by side with the normal one, leading to intense overcrowding which in cases makes it difficult to demarcate individual embryos in a group. The normal embryo can be distinguished usually from the nucellar embryos by the presence of a suspensor. Serial sections of a fairly mature seed show 2 or 3 embryos with developed cotyledons, and 10 or more others which have projected into the embryo sac cavity but with no cotyledons, and still more numerous embryos embedded in the nucellus (Fig. 4).

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[1] Schürhoff, *Der Zytologie der Bluten Pflanzen*, 1926.

[2] Schnarf, *Embryologie der Angiospermen*, 1929.

[3] Osawa, "Cytological and Experimental Studies in Citrus," *Coll. Agr. Tokyo*, 1912, 2.

A rigorous developmental selection seems to operate in the embryogeny of *Murraya kœnigi*. Though a large number of nucellar embryos take their origin only some 10-12 successfully develop further in the embryo-sac-cavity. Of these successful ones only 2 or 3 develop the cotyledons. The rest of the embryos are arrested in their growth at earlier stages of development.

R. S. Chakravarthy.

Central College,
Bangalore,
*February 2, 1935.*

**Fig. 1.** × 240.

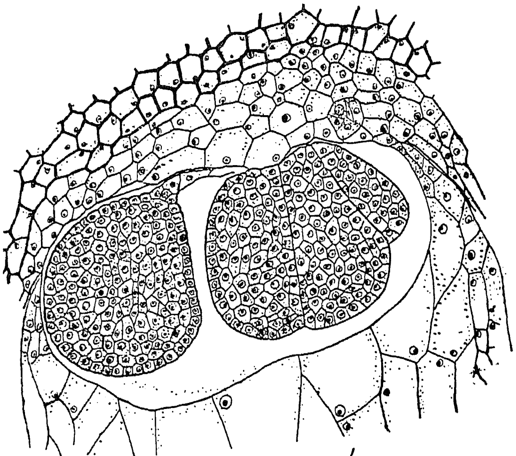
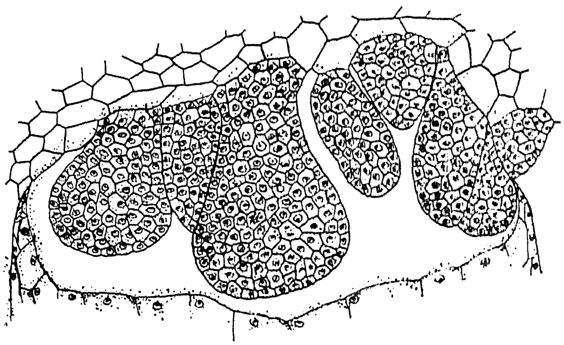


**Fig. 2.** × 240.



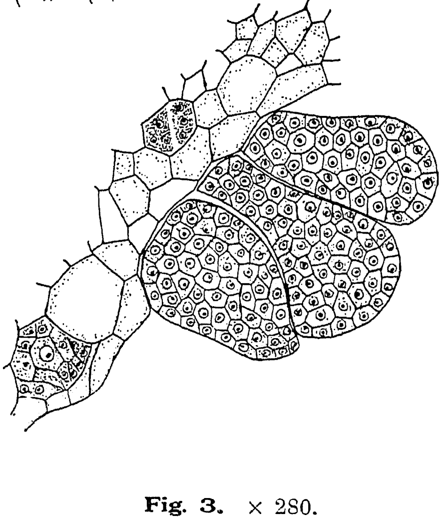


**Fig. 3.** × 280.

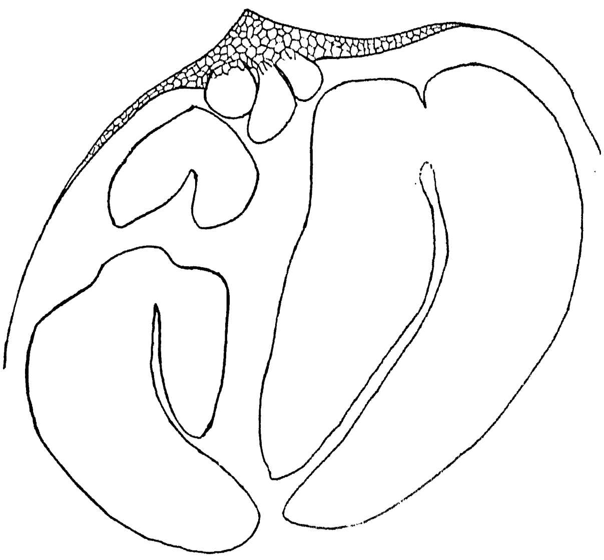


**Fig. 4.** × 80.

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## Bulbils in Sorghum.

The ordinary sorghum is from a single-seeded spikelet. There are some races in which the spikelets bear two seeds and occasionally three. In the case of two grains the extra one is borne in the axil of the third glume which develops a palea of its own. When three grains occur the third one is formed by the twinning of the usual grain in the fourth glume. In the second generation of certain crosses between double-seeded and single-seeded varieties small greenish bodies were noted in the spikelets at the pre-ripening stages. The whole population was examined and this curious phenomenon was confined to 8 plants in a total of 674. In these eight plants, 22 such structures were noticed, the maximum being three in a head. The spikelets were examined and it was noticed that these green bodies

were tiny bulbils resulting from the conversion of one of the grains into a leaf-like structure (see illustration). The bulbils ranged from 0·5 to 3·5 cm. in length, the most frequent being 2·5 cm. The pathological origin of these bulbils was suspected but a microscopic examination of the tissues did not reveal any such cause. Eight of the longest of these bulbils were planted out and nursed but none of them showed any tendency to live on. The rest of the spikelets were teased out and it was noticed that they were in structure like any other bulbil with 4–5 completely inrolled leaves which showed a progressive increase in length towards the top.

The occurrence of bulbils in both monocotyledons and dicotyledons has been recorded.

Sorghum-Bulbil. × 4

In the Gramineæ their occurrence has been noted in some genera. These bulbils vary in composition. They may be entirely leafy, have sessile flowers in the axils of their scale leaves, or have stalked flowers, resembling a miniature plant. The floral structures when present may have imperfections of degrees. In almost all cases these bulbils have been in the nature of a device at reproduction evading possible risks run by a direct propagation through seed. This instance of bulbil formation in grain sorghum lends to two possible explanations. The phenomenon of bulbil formation may be a premature index to prolificness, which doubling and trebling of grain connotes or may be in the nature of a primitive bent which some of the ancestors of sorghum may have had recourse to in their original habitat. A wide survey of the key regions of this Great Millet may throw helpful light in the interpretation of the occurrence of this rare phenomenon brought about through wide hybridisation.

G. N. RANGASWAMI AYYANGAR.
V. PANDURANGA RAO.

Millets Breeding Station,
Coimbatore.
*January 21, 1935.*

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## Sclerospora Sp. and Suppression of the Awn in Sorghum.

SCLEROSPORA has been known to attack Maize Teosinte, Sorghum, Bajri, and the Italian millet. There are records of the many effects of this infection on the host plant. In Maize, dwarfing of the plant, shortening of the internodes, chlorotic leaves, late heading, small cobs, absence of grain and a wide range of fasciations, phyllodies, reduplications and virescences have been observed. In Teosinte, sterility in spikelets, absence of stamens, withered anthers, non-functional pollen, proliferated florets are on record. In Bajri (*Pennisetum typhoides*), the pearl millet, it has been noted that the panicle is the most susceptible part. The upper segments of the floral axis get converted into a leafy shoot. Bristles become hypertrophied. Stamens get modified into a leaf-like body with sheath and blade. The pistil never develops.

In Jowar (Sorghum) it has been noted that the vegetative parts are more susceptible to this disease. The leaves turn yellow and shred. Earheads are produced with difficulty. They are small and have small grains. At the Millets Breeding Station, Coimbatore, one of the effects of this disease has been a shortening of the panicle branches, resulting in a more compact-looking earhead.

In the summer of 1931 a five tillered Sorghum plant in a long awned variety was noted to have one of its earheads without

awns. One young tiller was very badly affected with Sclerospora and did not flower. The other four tillers produced earheads. Three were normal with long awns, the awns being 7—9 mm. in length. The fourth earhead was small and its glumes did not have awns. The leaves of this tiller were shred. This head showed signs of late and weak anthesis. Its flowers were teased and it was noted that the stigmas were flabby and the lodicules and ovary shrunken. The anther lobes had shrivelled walls. Most pollen grains were plasmolised, empty or collapsed. Such of those as were healthy had germinated *in situ*—a remarkable fact—showing small tube growths. Malformed anthers were noted and in one case the atrophied anther lobes had no filament but were attached alongside of the short narrowing tip of a sessile spike-like body, probably homologous with the filament. The ovarian tissues were found to have been penetrated by a felt of mycelium.

The most noticeable feature of this attack is the suppression of the awn. It has been noted that the leaf-blade is the most susceptible part of the Sorghum plant in the attack by Sclerospora. Terratological and morphological evidences lead towards considering the awn as being homologous with the blade of the leaf.[1] This suppression of the awn as a pathological effect is therefore interesting. It has been noted that in one of the plants raised by pollinating with irradiated pollen there was a suppression of a majority of the leaf-blades.[2] The suppressions in the above instances lead to the interesting problem of tracing the affinities between direct pathological reactions and the induced suppressive effects of irradiation. In either case the susceptibility of the blade-awn organs and the comparative individuality of the sheath-glume structures (protecting buds and embryos) lead to interesting possibilities in the pursuit of the evolutionary factors operating towards a differentiation of the leaf into blade and sheath and their homologues.

G. N. RANGASWAMI AYYANGAR.
P. V. HARIHARAN.

Millets Breeding Station,
Coimbatore,
*January 21, 1935.*

[1] *New Phytol.*, 1934, **33**, 359.

[2] *Madras Agric. J.*, 1934, **22**, 448.

## On the Discovery of a Prehistoric Fossil Elephant in the Allahabad District.

THE news of the discovery of a 31 feet skeleton of some prehistoric animal in the Daiya estate (district not mentioned) was published in the *Leader* about six months ago. A similar report came out in some newspapers early in December last, but the place of occurrence was given as 'Datia State' in one paper and 'Doyra State' in another. On enquiry it was found to be Daiya estate towards the south-eastern part of the district of Allahabad.

The skeleton was found in the bed of a streamlet known as Tundiari Nala. The spot is about half a mile to the south-east of the village Murlipur (Lat. 24° 52′, Long. 82° 3′). A part of the skeleton exposed in the bed of the streamlet was first seen by some cowboys during the last summer. The landlord of the estate, Raja Bhagawati Prasad Singh, got the skeleton dug out in parts, as soon as the discovery came to his notice. On local enquiry the author learns that the fossil animal was found lying on its back, the head and forelimbs pointing upstream and the hind-limbs downstream. Parts of the limb bones were missing. The tusks were not in organic connection with the head. A part of one tusk was lying in the same line with one of the hind-limbs. This was included in the measurement of the animal, which the villagers took to be a giant human individual. This mistake was possible because the skeletal parts are not well preserved and the facial features were concealed by the matrix.

The animal concerned appears to be a representative of *Palæoloxodon namadicus*, an extinct species of elephant which is supposed to be more closely related to the living African elephant than the living Indian species. The type for this species is a very perfect specimen of a cranium figured (Pls. XIIA, XIIB) by Falconer and Cautley in the "Fauna Antiqua Sivalensis" under the name of '*Elephas (Euelephs) Namadicus*'. The specimen was obtained from the Narbada alluvium and is preserved in the British Museum. The bulk of the material referred to this species comes from different localities situated along the Narbada valley. But a specimen was discovered in the Godavari alluvium also. A few molars are reported to have come from the Irrawaddy valley in Burma, but no definite history of this find is available. Outside

India, the species is known from China, Japan and Java. This species resembles a variety of *Palæoloxodon antiqus* of Europe, which is characterised by broad-crowned molars; and by some authorities they are regarded as identical.

The present discovery is particularly interesting in view of the fact that it has been made in a country covered by rocks belonging to the Vindhyan System. At the site of occurrence the streamlet cuts through a *Kankar* bed, which is probably an alluvium formed during the middle or the latter part of the Pleistocene epoch. This formation is exposed at the bed from where the skeleton was excavated, and also at the vertical cliffs on the two sides having a height of 12 feet and above.

The skeleton has been presented to the Geological Museum of the Benares Hindu University. An anatomical study of the specimen is in progress, and a description will be published in due course.

D. K. CHAKRAVARTI.

Geological Museum,
Benares Hindu University,
*January* 30, 1935.

## On the Occurrence of Foraminifers and Radiolarians in the Infra-Trappean Limestones near Pangadi—Rajahmundry.

It is well known that the only detailed account of the infra- and inter-trappean rocks of the Rajahmundry area is the one published by William King[1] so far back as 1880. During a recent visit, we have been able to collect a number of limestones associated with the Deccan traps of this area. In the course of a microscopic examination of these rocks, it is found that some of the infra-trappean limestones found near Dudukur and Gowripatnam reveal the presence of numerous forminifers and a few radiolarians in them —one type of limestone particularly—being almost wholly composed of foraminiferal shells. Most of these foraminifers belong to the family Rotalidæ—the common forms being Rotalia, Discorbina and Pulvinulina. A few shells of Globigerina and one or two types of Miliolines are also recognisable.

These micro-organisms from the infra-trappean limestones resemble in their general character, those described sometime back by Prof. L. Rama Rao[2] from some of the rocks of the Utatur division (Cenomanian) of the Trichinopoly Cretaceous.

A detailed account of the micro-organisms from the limestones under study will be published elsewhere.

S. R. NARAYANA RAO.
K. SRIPADA RAO.

Department of Geology,
University of Mysore,
Mysore,
*February* 3, 1935.

[1] *Mem. Geol. Surv. of India*, 1880, **16**, Pt. 3, 37-54.

[2] (*a*) *Quart. Journ. Geol. Min. Met. Soc., Calcutta*, 1931, **3**, No. 2: (*b*) *Journ. Roy. Micro. Soc., London*, 1932, **52**, 357-361.

## On the Nomenclature of Lac Insects.

For reasons of priority Cockerell* suggested that the name *Laccifer*, Oken, should be adopted for designating the genus of the lac insect. Before Oken, Roxburg published an article entitled, "On the Lacsha or Lac insect", which appeared in two forms. It first appeared in the *Asiatic Researches*§ with an introduction by Anderson, who wrote to Sir William Jones, the Editor, that, "Roxburg's discovery will bring lac, a genus, into the class Hemiptera of Linneus". Now Anderson himself had discovered and named the wax insect, *Ceroplastes ceriferus*, while Roxburg was then the most renowned systematic botanist in India. As energetic systematists they must have understood how to bring a new genus to include the lac insect into the Linnean system of nomenclature.

But Sir William Jones was personally interested in utilising Sanskrit names for a scientific vocabulary and had actually written an article creating some examples and demonstrating such a possibility. Either Roxburg and Anderson, knowing Sir W. Jones's keen interest, left the matter to his decision or the latter changed it to Lacsha for, as though he was offering an explanation for his choice, he endorses saying, "the Hindus have six names for lac but they generally call it Lacsha".

Roxburg's article, without Anderson's foreword, was published in *Phil. Trans.*, 1791. This had a much wider circulation than *Asiatic Res.*, and Oken remained absolutely unaware of any previous desire on the part of a systematic biologist to bring the lac insect into the class Hemiptera of Linneus.

* *Psyche*, 1924, **31**.

§ *Asiatic Researches*, 1790, **2**.

It is unfortunate that most writers who have accepted the name *Laccifer* have had no access to the complete article of Roxburg.

Sir W. Jones would prefer a purely Indian word, Lacsha, but the name suffers from the disadvantages of being common place in a land like India where it already connotes an article of household use. It is suggested that *Lakshadia* would be more appropriate as a generic name while *Lacsha* has all the claims of priority over *Laccifer*.

S. MAHDI HASSAN.
"Abid Manzil,"
Hyderabad (Deccan),
*January* 25, 1935.

### Wax-Production in Aleurodidæ.*

THE secretion of wax is a very commonplace phenomenon in many of the Homoptera and is particularly noticeable in all the families of Sternorhyncha. Wax is secreted by special structures known as *wax-glands*, *wax-cells* and *wax-pores*. The arrangement, position and structure of these may differ in different families. The secretion of wax is found in the larval as well as in the adult stages. In the family Aleurodidæ, wax-secretion is profuse in the adults of all the species, but not found to the same extent in the larvæ. Generally three types of wax-pores are found in the larvæ of Aleurodidæ—(1) Simple, (2) Agglomerate, and (3) Compound. The structure of the simple and compound wax-pores is as follows :—

Simple wax-pores are circular holes of small or large size in diameter from ·017 mm. to ·027 mm. These exist in greater numbers in those species which secrete a large quantity of wax. In compound pores the holes have a chitinous ring surrounding them and a definite elevated cup-like structure. Within the cup the pores are arranged in a ring and are produced into more or less elevated rods or tubes.

In the Adults there are chitinous plates which are placed ventrally on the abdominal segments and are known as wax-plates. These may be comparable to the wax-plates in honey bees. There are two pairs of these plates in the female placed on the 3rd and 4th segments respectively and four pairs in the male on the 3rd, 4th, 5th and 6th segments. These wax-plates appear like thick pads and are oily yellow in appearance. They are separated by a median line in the centre of the abdomen but extend considerably outwards on both sides so that they can be very clearly seen laterally as they are bounded by a black line.

In the female both the plates appear to be equal in dimensions, but in the male the first one is bigger and the succeeding ones gradually reduced in size. When viewed under microscope these present an appearance of plates possessing minute holes arranged in regular rows.

When highly magnified (1,200 times under the oil-immersion lens) these holes appear like cells in a honey comb. These are the minute circular pores through which wax comes out or is forced out in small minute particles or threads. In thin microtome sections taken through these wax-glands there is seen a single layer of secreting cells with large nuclei which contain vacuoles. There are numerous granules in these vacuoles which are found in a large number towards the outer side.

A careful examination of these plates in a male of *T. vaporariorum*, under a very high magnification, shows that each of the last three plates contains 40 rows of 90 cells each at an average; the first one has 50 rows as it is larger. Thus the total number of pores of one side comes to $3,600 \times 3 = 10,800$ *plus* $50 \times 90 = 4,500 = 15,300$ or approximately 15,500 and both the sides together will bring the number to 31,000. Each side on the abdomen the space occupied (longitudinally) is ·3 mm. In the female there are only two pairs of plates which are rather broader and occupy space to the extent of ·23 mm. each side. Each of the plates contains pores in rows of $63 \times 95$ and $60 \times 95$ cells respectively. The total number of pores on one side thus comes to 11,685 or nearly 12,000. It is not understood why the number of pores is less in females.

Freshly hatched specimens are perfectly free from any wax particles soon after emergence. The wax-plates, not being at work, cannot be marked out very clearly.

I give below my observation on a specimen for about 5 hours from its emergence. It was a male. It extricated itself with great difficulty from the pupal case which operation took about an hour. This was at 10 a.m. In the first two hours no wax was seen being secreted but only the wax-plates assumed an oily olive appearance.

* These observations were made on *Trialeurodes vaporariorum*—the greenhouse white fly—at Edinburgh, under Dr. C. B. Williams, now the Chief Entomologist, Rothamsted, England.

Then one of the plates (on the left side) was seen covered with white flocculent material which soon after drying became white. The insect (which was under a binocular) was actively moving its legs first of one side and then of the other. In that way the legs actually brushed off the wax accumulated on the plate and by dashing the legs here and there it distributed the wax or the meal all over the body.

As the plates on the left side were active, the left side of the body was covered with wax, first the abdomen and its end, then the underside of the wings and then the front part of the body. Gradually all the plates began to secrete wax which was being spread all over the body. All the plates were in full action by 3 p.m., *i.e.*, 5 hours after emergence.

The structure of the meal or the wax secreted is very peculiar. It is in the form of spiral threads as if forced out through small holes, but under abnormal conditions, or if the meal is not constantly removed by the brushes on legs, it assumes the form of long threads appearing like silken combs or tufts. While observing the eclosion of flies from the pupæ, I have seen several specimens with three-fourths of their body out and struggling hard to extricate the last part of the body. The insect is standing erect and dashing its legs in the air and with wings in the unexpanded condition. The wax-plates are active and the wax begins to appear on the body. As no brushing off is possible in that condition, the wax goes on accumulating and a very thick brush-like layer is formed.

Under microscope these appear like bunches of long threads with one end curved. I have also observed cases of partial emergence wherein the flies have died after the upper part of the body head and thorax having come out and the abdomen remaining inside the pupal case. In such cases I have found after pulling out the abdomen that it was full of waxy brushes, proving thereby that the wax-plates were actively secreting wax even if the abdomen was enclosed in the pupal covering.

V. G. DESHPANDE.

Department of Agriculture,
Bombay,
*January*, 1935.

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## Hermaphroditism in *Lycastis indica* (Southern).

HERMAPHRODITISM in Polychæta is of such rare occurrence that only about a score of forms are known to be bisexual out of several hundreds of species described. Most of these belong to families Sabellidæ and Nereidæ and among the latter, *Lycastis quadraticeps* (Gay) has been described by H. P. Johnson[1,2] from the Straits of Magellan on the Chilean coast, as exhibiting the phenomena of hermaphroditism and gigantic ova. Many species of *Lycastis* have been recorded in recent years mostly from Sumatra and Java, the genus now consisting of about a dozen distinct species, leaving out one or two doubtful cases. With the exception of *Lycastis brevicornis* (Aud et M. Edw., 1832-34), first described from the coast of France but which has not been rediscovered, all the known species are from the tropics. They are capable of enduring great variations in salinity and sometimes even enter fresh-water and many of them are gradually getting themselves adapted to life in wet mud like earthworms. *Lycastis indica* (Southern), the only known Indian species of this genus, is common in the backwaters of Cochin, Madras and Calcutta and several other places in India and probably also has a much wider coastal distribution than is at present known. In Madras the author has seen it inhabiting situations where the salinity is nearly as high as that of the sea and more frequently in places where the water is almost fresh, the species having been taken even from pools of fresh-water near Adyar.

The worms usually attain a size of 20 to 25 cms. Gonads develop rather early in life. Thorough examination of some hundreds of specimens reveals that *Lycastis indica* is hermaphrodite and protandrous. The male sexual elements appear first and when young the worms pass through a male phase, the body cavity now containing masses of motile spermatozoa only. The ova develop later in life, both motile sperms and mature ova occurring in almost all the segments, the worm now being truly hermaphrodite. This

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[1] Johnson, H.P., "Fresh-Water Nereids from the Pacific Coast and Hawaii with General Remarks on Fresh-Water Polychæta," *Mark Anniversary Volume*, 1903, 205–223.

[2] Johnson, H. P., "*Lycastis quadraticeps*, a hermaphrodite Nereid with gigantic ova", *Bio. Bull.*, 1907-8, **14**, 371–386.

condition is observed in all the full-sized worms. A detailed account of the life-history and the bionomics of this interesting Nereid will be published shortly.

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*January, 1935.*

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## The Existence of the Intervertebral Ligament in the Vertebral Column of a Perennibranchiata (*Necturus maculatus*).

GADOW[1] has stated: "In many Urodela, especially in the Perennibranchiata, the whole intervertebral cartilage acts as the joint, being, in fact, a flexible mass intercalated between the bases of the hollow calcified cones of the successive vertebræ. However imperfect this joint may be, it does fulfil the requirements of these long-bodied and long-tailed aquatic Urodela."

Subsequent authors like Schauinsland,[2] Kingsley[3] and Goodrich[4] have supported the statement of Gadow.

On examining an adult specimen of *Necturus maculatus* we found that its body is quite flexible like that of an ordinary teleostean fish. This led us to reinvestigate the development of the intervertebral elements of *Necturus maculatus* and we have found the existence of an intervertebral ligament like that of the fish.

Mookerjee[5] has shown that in all Vertebrata the skeletogenous layer aggregates round the notochordal sheaths forming the perichordal tube. The same author[6] has shown for the first time in a higher Urodela, such as in *Triton vulgaris* that the Vertebral portions of the perichordal tube soon becomes osseous forming a series of hour-glass-shaped bony rings while the intervertebral regions of it remain cartilaginous. Each intervertebral cartilaginous ring is overlapped by the osseous vertebral rings: but the overlap of one does not meet the overlap of the next, so that the middle of the intervertebral cartilage ring remains unprotected. A strand of migratory connective tissue cells grows into the cartilaginous perichordal ring in a caudal to cranial direction forming a complete arc through the interspace between the two successive hour-glass-shaped centra, and then a split appears within the line of this arc of connective tissue cells, thus forming a synovial cavity. The intervertebral cartilage is divided into a ball and socket; the ball articulates with the front end of a vertebra and the socket with the posterior end of the previous vertebra. The connective tissue cells lining the synovial cavity become cartilaginous, forming the surfaces of the ball and socket. So each vertebra has a ball in front and a socket at the back forming an ophisthocœlous vertebra.

Graham Kerr[7] has stated that the intervertebral cartilage in Urodela increases considerably in thickness, bulging out between the adjacent somewhat expanded ends of the bony tube. The statement of Graham Kerr is incorrect as one could easily see that in an early stage these migratory connective tissue cells are outside the intervertebral cartilage and at a later stage they could be seen migrated within the intervertebral cartilage.

In *Necturus maculatus* an almost identical condition can be seen with certain modifications. After the formation of the hour-glass-shaped centra and the cartilaginous intervertebral rings, the migratory connective tissue cells instead of getting in an arc, go inside it at right-angles to the rings. These connective tissue cells soon become a ligament. A transverse section through the anterior region of the intervertebral cartilage of the trunk region of *Necturus maculatus* at 48 mm. stage, shows the cartilaginous cells outside the notochordal sheath which is surrounded by the osseous ring of the hour-glass-shaped centrum which overlapped on the intervertebral cartilage (Fig. 1). A section passing through the middle region of the intervertebral cartilage which remains unprotected, clearly shows that the migratory connective tissue cells have entered inside the intervertebral cartilage and have constricted the notochord considerably.

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1 Gadow, H., *Phil. Trans. Roy. Soc.* (B), 1896, **187,** 1–57.

2 Schauinsland, H., *Handbuch der vergl. u. experim. Entw-lehre der Wirbeltiere. von Osker Hertwig*, 1906, **3,** 339-572.

3 Kingsley, J. S., *The Vertebrate Skeleton*, 1925, 38.

4 Goodrich, E. S., *Studies on the Structure and Development of Vertebrates*, 1930, 51.

5 Mookerjee, H. K., *Nature*, August 4, 1934, **134,** 182.

6 Mookerjee, H. K., *Phil. Trans. Roy. Soc.* (B), 1930, **218,** 415–446.

7 Graham Kerr, J., *Text-book of Embryology*, 1919, **2,** 299.

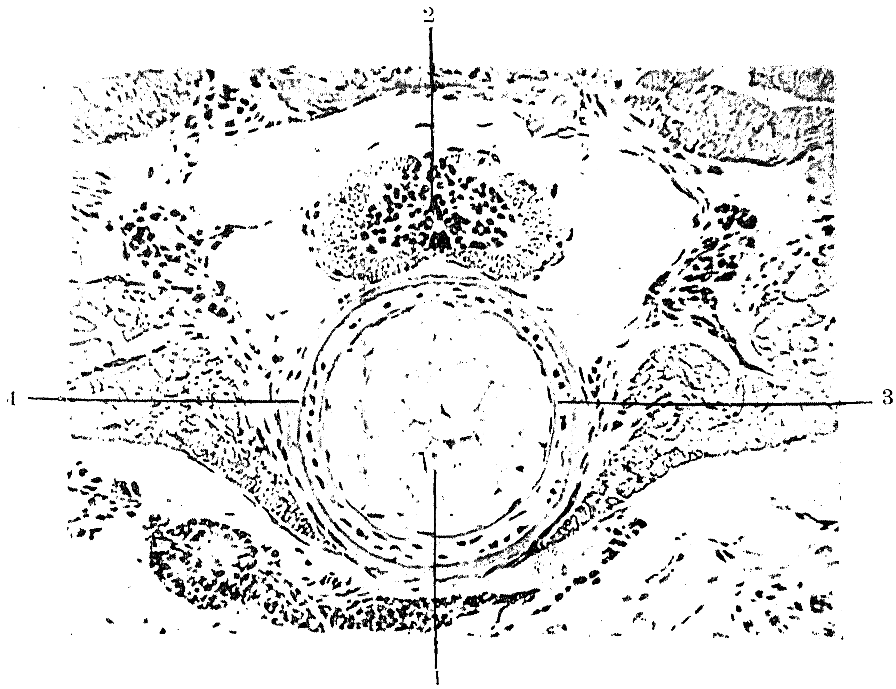


**Fig. 1.**

Transverse Section through the anterior region of the intervertebral cartilaginous ring of a trunk vertebra of *Necturus maculatus* at 48 mm. ×90.

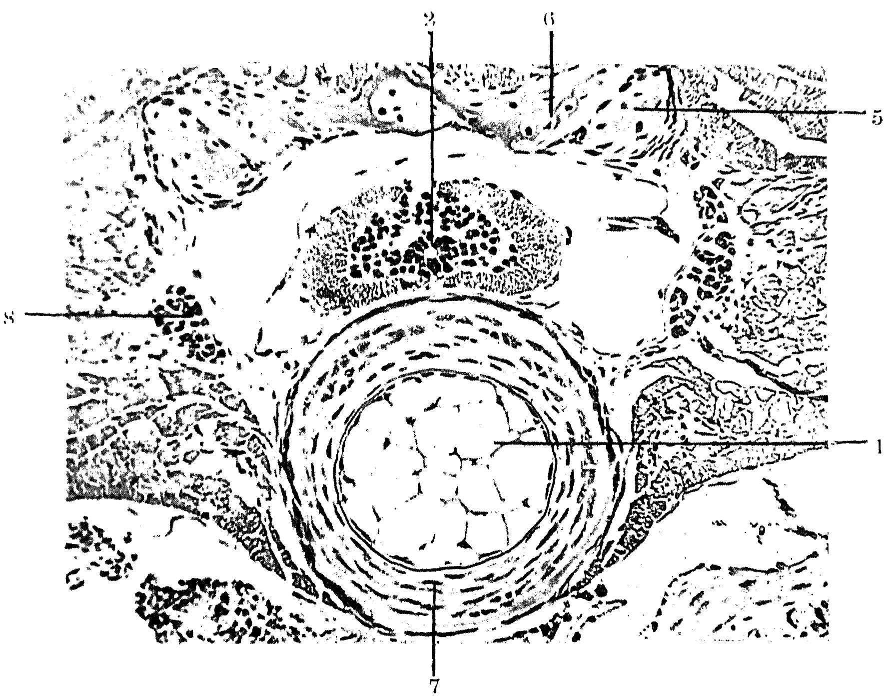


**Fig. 2.**

Transverse Section through the middle region of the intervertebral cartilaginous ring of a trunk vertebra of *Necturus maculatus* at 48 mm. ×90.

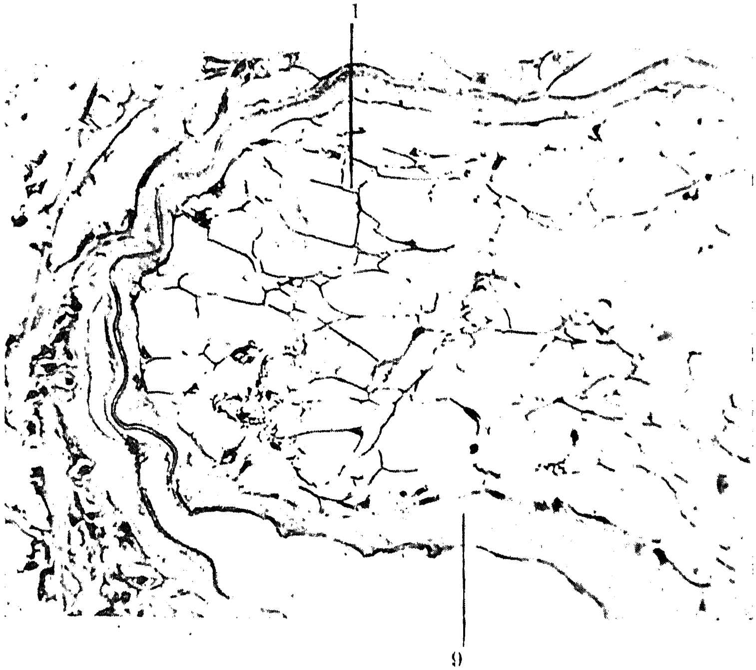


**Fig. 3.**

Transverse Section through the intervertebral ligament of an adult *Necturus maculatus.* × 100.

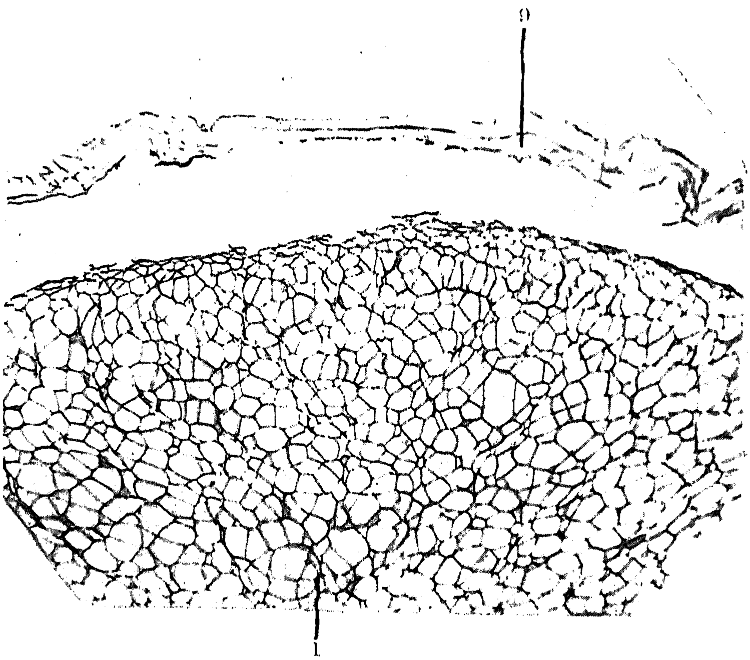


**Fig. 4.**

A part of the Transverse Section through the intervertebral ligament of an adult *Labeo rohita.* × 70.

*1. Notochord; 2. Spinal cord; 3. Cartilaginous intervertebral ring; 4. Osseous vertebral ring; 5. Pre-zygapophysis; 6. Post-zygapophysis; 7. Migratory connective tissue cells inside the middle region of the intervertebral ring; 8. Spinal nerve ganglion; 9. Intervertebral ligament.*

These migratory connective tissue cells are responsible for the formation of the intervertebral ligament (Fig. 2). For the sake of comparison we have given a transverse section of the intervertebral ligament of an adult *Necturus maculatus* (Fig. 3), and a part of a transverse section of the intervertebral ligament of an adult fish *Labeo rohita* (Fig. 4). From these two figures one can easily make out that they are almost identical structures. The evidences that are before us lead us to believe that the previous workers did not trace the development of the vertebral column of Perennibranchiata up to its maturity, otherwise they would not have missed the existence of the intervertebral ligament. Of course the connective tissue cells that migrate inside the intervertebral cartilage were unknown to them.

In conclusion we may say that aquatic animals like *Necturus maculatus* would not have been able to protect themselves from their powerful enemies had they not had a very flexible body in order to change the direction at a moment's notice when they were chased by their deadly enemies. A rigid structure like intervertebral cartilage cannot allow such a flexibility.

HIMADRI KUMAR MOOKERJEE.
SURYYA KANTA DAS.

Department of Zoology,
University of Calcutta,
*January 18, 1935.*

## Stricken Ceylon.

THE outbreak of malaria in a serious epidemic form in apparently healthy parts of Ceylon raises grave scientific problems which concern the public health of not only this island but also of other Eastern countries. The telegrams in the Press report that this scourge has been followed by other diseases such as dysentery and cholera. In the affected provinces, which are not yet free, the total mortality due to all these diseases must be well over 30,000. The situation is worsened by the prevalence of famine.

It seems to us that the enquiry into the causes of such a sudden outbreak of diseases in normally healthy districts, should deal with both the scientific and economic problems of the country. There are numerous species of *Anopheles* in Ceylon and it is unlikely that any one of them or the larger number of them can be held to be responsible for the recent epidemic. We may hazard the hypothesis that the boats calling at the ports of Ceylon from Singapore in larger numbers within recent times, perhaps may have introduced an exotic species of *Anopheles*, or the Ceylon coolies working in "Singapore Naval Base", may have brought the virulent type of malaria from the Malaya Peninsula. The recent famine must have lowered the resistance capacity of the people, and the pools in the river beds must have furnished the breeding grounds for these Malayan mosquitoes which, swarming round the inhabited areas, spread the disease. Recently a great deal of exploratory work in the jungles, where the ancient kingdoms of Ceylon lie buried, has been in progress, and the workmen catching the infection in these malaria-ridden tracts, may have spread it.

The investigation which is likely to be undertaken, will, we hope, be sufficiently wide in its scope, and the report ought to include constructive proposals for the prevention of recurrence of such epidemics.

# The North Bihar Earthquake, 1934.

A SYMPOSIUM on the origin of the North Bihar Earthquake of January 15th, 1934, was held at a joint meeting of the Mathematics, Physics and Geology Sections of the Indian Science Congress, 1935, under the Chairmanship of Dr. L. L. Fermor. The following is a summary of the speeches.

## S. K. BANERJI.

*Meteorological Department.*

The earthquake which occurred in North Bihar on January 15, 1934, had many important peculiarities : it was felt over an area of not less than 3 million square miles—an area which is perhaps greater than that of any previously recorded earthquake. The surface vibrations were felt at greater distances towards the south and west than the north and east, the Himalayas in the north and the Assam and Burma mountains in the east acting as barriers and damping them out considerably.

We find that the energy of this earthquake was slightly greater than $10^{22}$ ergs. An energy of this order could be produced by the fracture of a quadrangular rock of dimensions not less than 150 km. × 100 km. and thickness 10 km. This would suggest that the focus of this earthquake must have covered a wide volume and the epicentral track a fairly wide area.

The very great preponderance of surface waves on this earthquake, as well as the type of movements in the preliminary and the secondary phases all suggest that this earthquake had a shallow focus. With this information in our possession, the question arises whether seismology can make any definite contribution to the search for the cause of this earthquake.

It is almost certain that isostatic compensation holds in the case of such large mountains as the Himalayas. For calculation shows that the stress difference required to support mountains of height 10,000 meters above the adjacent valley, in a uniform crust, would be about $10^9$ dynes/cm$^2$. This is near the crushing strength of basalt, which could, therefore, just support the Himalayas if the stresses necessary could be distributed over an infinite depth. The Himalayas, apart from being very high, are of such large horizontal extent that they would very probably produce breaking stresses in the lithosphere assumed to be of finite thickness. It is therefore very likely that they are bounded by fault-planes so that they can move up and down independently, that is to say, float on the lithosphere and undergo up and down movements without disturbing the surface crust over the continents. The upward motion of the mountains can, of course, occur as a consequence of denudation and if they are floating more or less independently of the continents the gravity anomalies found in the Gangetic plain and elsewhere are probably not of much importance as undoubtedly the cohesion of the materials forming the continental crust is able to support a small departure from perfect isostasy.

The earthquake occurred on a new-moon day, and on such a day we get a body tide due to the elastic yielding of the solid material of the earth, such that the height of the oceans, as measured by the rise and fall of the sea, relative to the land is reduced to about $^2/_3$ of the true equilibrium height (if the rigidity of earth be assumed to be the same as that of steel). On that day also an atmospheric disturbance was passing over Northern India and Darwin has shown that if the difference of barometric pressure between consecutive regions of "high" and low" pressures be 5 cm. of mercury and if the centres of 'high' and 'low' be 1500 miles apart, then as a consequence of the yielding of the ground, it will be 9 cms. higher under the barometric depression than under the elevation. These causes could therefore conceivably have served to produce a kind of trigger action.

A simple seismograph in which hydraulic magnification and damping were used and which could be worked near earthquake zones was demonstrated.

## S. C. ROY.

*Meteorological Department.*

Dr. Roy stated that a study of the various seismographic records of this earthquake may enable us to deduce the constitution of the outer crust of the earth in Bihar. He estimated the probable thicknesses of the upper and intermediate layers of the crust and from various data calculated the focal depth of the North Bihar shocks to be about 13 km. He said that the focal depth and the thickness of the upper layer suggest that the major failure leading to the disastrous earthquake of January 15th, 1934, occurred near the boundary of the upper and intermediate layers of the earth's crust. A fuller account of Dr. Roy's contribution to this discussion has already appeared in *Current Science*, 1935, **3**, 298.

## D. N. WADIA.

*Geological Survey of India.*

Among the suggested causes of the recent Bihar earthquake is the one based on the theory of the *underload* of the Bihar plains, due to their being covered by thick alluvial deposits which are about 18% lighter than normal rock. The region extending from Meerut to beyond Dacca has been found by means of gravity measurements to be of great defect of matter, as if this part of India suffers from a lack of some ½ mile of thickness of rock-deposits. On the two flanks of this belt lie the high Himalaya to the north and the highlands of the Peninsula to the south—areas of overload where the crust supports more than the normal load. These loading anomalies must, under the theory of isostatic balance of all large segments of the earth, cause considerable stress-differences in the earth's crust—stresses which may seek relief in occasional earthquakes. The load anomaly, however, in the present case appears to be too slight (in view of the fact that the Himalaya range is more or less *compensated*) to be a competent originating cause, though it may operate as a contributory cause. Most of the great earthquakes in other parts of the world have been traced, directly or indirectly, to weak underground structures, such as folds and faults on the strata, which occasionally give way under long continued strains ; and it is in the structural plan or architecture of this part of India—which has been the seat of the great majority of recorded

Indian earthquakes since the 14th century—that we should seek for a cause. The underground structure below the plains of Bihar is that of a sunken, trough-shaped basin filled up during late geological times by river alluvia. The floor of this sagged tract is disrupted by several fracture lines, some proved and others hypothetical, but based on collateral evidence, while there is some amount of wrinkling of the strata where the Himalaya joins the plains. The earthquake of January last has proved to be a complex one with 3 distinct epicentra two of which traverse Bihar roughly W.N.W.-E.S.E., parallel with the trend of the Himalayas. One of these is at Khatmandu. But the principal epicentra of the Bihar earthquake, which have given some surprise and uneasiness to Indian geologists and which throw new light on the structure of India, are two well-defined lines to the north and south of the Ganges brought out during the field investigations by the officers of the Geological Survey of India.* The best marked of these lines is the line from Betiah to Purnea while the third epicentral tract extends from Patna to Monghyr. These tracts are too far south of the Boundary faults and the severe shaking which they experienced must be due to other more or less parallel fault-lines in the floor of the trough between which a block of the sub-crust underneath Bihar subsided. I would, however, mention here that the relatively high destructivity of the quake at places like Monghyr, Jamalpur, Purnea and probably also Khatmandu, was due not to any special focal or nodal seismic intensity, but to the accidental circumstances of their sites, which have produced local exaggeration or intensification of the earth-waves. In the case of Monghyr and Jamalpur, in my opinion, a disastrous intensification of the ground vibrations resulted from the junction of two rock-bodies of quite different elasticities. These cities are built partly on ancient crystalline rock of great rigidity and partly on loose alluvial deposits—the period of vibration of such a rigid rock being quite different from that of the adjacent loosely aggregated alluvium, the elastic recoil of the latter may have produced a destructive rocking of the ground, its amplitude being too great for the old masonry houses. In the case of numerous earthquakes it has been found that the junction-plane of rock bodies of different rigidity is a line of special weakness and destruction. In the case of Purnea the greater destructiveness of the shocks may be ascribed to the weak sub-strat m of the town—a thick bed 60 to 80 feet, of very fine soft sand, of practically no elasticity.

### AFTERSHOCKS.

All great earthquakes are succeeded by a large number, sometimes several hundreds, of aftershocks and they often throw light upon the direction and extent of the fractures in the crust which originated the principal shock. A record of such shocks during the years 1934 and 1935 is likely to have much significance on the location of the postulated lines of faulting and dislocation underneath the Betiah-Purnea and the Patna-Monghyr epicentra. A careful and continuous record of the aftershocks in areas of great earthquakes has proved of help in studying the main quake which ushered them in. The several thousand aftershocks of the Assam earthquake of 1897 indicated the courses of the thrust-planes and faults which precipitated that great quake. The shifting of the epicentra of these subsequent minor tremors from point to point and their clustering at certain points provide data for the mapping of the subsidiary and branch-faults associated with the major dislocations of the ground.

### A PLEA FOR THE ESTABLISHMENT OF MORE SEISMOGRAPHIC STATIONS.

The seismic zone of India possesses but few recording stations and these more often than not fail to produce a complete graph when the intensity exceeds a certain degree or when they are situated at all close to the focus. It would be materially helpful if, say, 8 to 10 recording stations are established between Peshawar and Assam. A seismograph is not necessarily a costly instrument, nor is it necessary that all instruments should be of extreme sensitiveness. Seismographs can be constructed costing from Rs. 500 to Rs. 1,000 and can be easily kept under observation at various University laboratories and periodically visited by a meteorological expert. Such recorders may in course of time collect valuable data for use in demarcating the boundaries of the seismic belt in India. The use of microseisms in locating fault-lines has been lately proved by the Japanese and American seismological laboratories, and the value of obtaining some definite data through these means regarding the course and extent of the faults concealed under the most densely populated parts of India cannot be over-estimated.

Seismic recorders can also be utilised to obtain a more definite estimate of the depth of alluvium under the Indo-Gangetic plains and incidentally of the nature of the floor and the existence of any hidden spurs or bluffs of rock, *e.g.*, the one near Monghyr.

W. D. WEST.

*Geological Survey of India.*

It is generally assumed that earthquakes around India are closely associated with faults in the Himalaya or in the rocks beneath the alluvium in front of the Himalaya. But if we consider the two greatest Indian earthquakes prior to the Bihar earthquake, namely, the Assam earthquake of 1897, and the Kangra valley earthquake of 1905, we find that in neither case could it be shown that actual movement had taken place along any known fault. In the absence, therefore, of any direct evidence for connection with faults, it is desirable to look for other possible causes.

The geodetic work of the Survey of India throws interesting light on the underground structure of India. Determinations of the force of gravity and of the deflection of the plumb line in a large number of places in India have revealed an anomalous distribution of crustal density, even after making allowances for the effects of topography, and for the variations in the rocks found on the surface. This led Sir Sidney Burrard to postulate his 'Hidden Range' or area of excess density within the crust, which runs across India in a W.N.W. direction through Jubbulpore. It is followed to the north by a parallel underground 'trough' in which there is a deficiency of density the lowest point of which is beneath the northern slopes of the Himalaya. It has been suggested that this deficiency can be accounted for by the

* J. B. Auden and A. M. N. Ghosh, *Rec. Geol. Surv. Ind.*, 1934, **68**, 177-239.

presence of the light Gangetic alluvium. But there would have to be something like 50,000 feet of alluvium to account for it, and this is extremely improbable. Similarly the high density which is observed further south above the 'Hidden Range' cannot be accounted for by the surface rocks. Moreover, the fact that there is another area of even greater gravity deficiency in Mysore, where the surface rocks are moderately dense—Deccan Trap, metamorphosed sedimentary rocks, and igneous rocks—indicates that these gravity anomalies have no connection with the density of the surface rocks. Recently this problem has been studied in greater detail by Major Glennie, who suggests that the anomalies are due to the buckling of the granitic, basaltic and dunite (or eclogite) layers of the earth's crust.[1] He postulates that there has, for long, been a deep trough or downward warping along the line of the geosyncline of 'Tethys' sea which is known to have existed for a long time, and in which the marine deposits were laid down which eventually gave rise to the present Himalaya on being crumpled. There are, however, two alternative ways of explaining on these lines the phenomena of a continuously sinking geosyncline. We may either assume that the granite-basalt surface, or the basalt-eclogite surface, has buckled up beneath the area of high density, and buckled down beneath the area of low density, as suggested by Glennie; or we may assume that there has been an actual change from basalt to eclogite or *vice versa*. It was long ago pointed out by Dr. L. L. Fermor that basalt and eclogite are rocks having the same chemical composition but different densities, eclogite being composed of minerals, such as garnet, of high density, while basalt is composed of minerals of lower density but similar composition.[2] Such a change might take place with great rapidity, since the change from eclogite to basalt is an exothermic one and so might spread rapidly through a large body of rock which was near the critical point. That some such sudden and deep-seated change could produce an earthquake shock of great intensity has been recently suggested by Oldham.

It is of course fully recognised that the formation of the Himalaya during Tertiary times must have left behind a legacy of unrivalled stresses, stresses which may be continuing to-day, if not in the Himalayas themselves, perhaps in the rocks in front of the Himalayas beneath the alluvium, the relief of which might provide earthquake shocks of great intensity. Whether the Bihar earthquake was due to some sudden deep-seated change of the kind suggested above, or whether it was due to a continuation of the forces which brought the Himalaya into existence, might be decided if the depth of focus of the earthquake could be determined. If it can be shown to be more than, say, 10 kms., then the former hypothesis is more likely to be correct. A lesser depth would indicate a connection with faults in the upper rocks of the crust. Dr. Roy's estimate of 13 kms., if sound, is thus of considerable interest.

This suggestion that the Bihar earthquake (and other earthquakes around India) had a deeper seated origin than is generally supposed, and that it may have had no connection with faults within the surface rocks is not put forward in any dogmatic way, but merely in order to show that the orthodox view concerning the association of Indian earthquakes with faults in the upper rocks may not necessarily be correct. That both the earthquakes and the formation of the Himalaya are manifestations of some change taking place at depth within the earth's crust is perhaps the more correct way of putting it.

[1] *Survey of India, Professional Paper*, 1932, No. 27.

[2] *Rec. Geol. Surv. Ind.*, 1913, **43**, 41.

C. W. B. NORMAND.
*Meteorological Department.*

Examination of the Indian seismograms recorded during the Bihar earthquake has emphasised anew three needs: (*a*) additional seismographs of a new type that will record the ground movement during severe earthquakes at distances up to 500 miles from the epicentre; (*b*) the damping of the pendulum movement of the Omori instruments; and (*c*) more numerous seismological stations in the neighbourhood of the Himalayan seismic zone. Regarding (*a*) Dr. Banerji's new instrument is in the experimental stage and promises well but need not deter other physicists from developing other designs. Regarding (*c*) the instruments at Calcutta, Agra and Dehra Dun ought to be supplemented at least by instruments in upper Assam, Bihar, the north Punjab or Peshawar or Kashmir, and Sind or Baluchistan. Could some colleges assist by the installation of seismological stations in these areas? An added advantage of this from the geophysicist's point of view would lie in the possible divergence of the research activities of a few more physicists in colleges in India towards geophysical studies.

A. C. BANERJI.
*Allahabad University.*

It is now generally recognised that earthquakes are started by fractures in the earth's crust caused by immense stress-difference developed in the layers of the crust. This stress-difference is produced by the unequal cooling of different parts of the earth's crust after solidification. These parts have contracted in volume by different amounts and a state of stress has thus been set up.

It is generally accepted that the surface temperature of the earth has remained constant since solidification. The loss of heat from the surface is balanced by heat generated from radio-active substances. It is found by calculation that a depth of about 20 km. of standard surface rocks containing radio-active substances would keep the surface temperature constant.

As the outer surface of the earth undergoes no further coolings and contraction it is therefore too large to fit the contracted region situated below. There is also an intermediate layer where the contraction is just enough to fit the interior. This is the "level of no strain". The outer loose jacket is therefore under a horizontal crushing stress; crumpling begins at the weakest point and folds are formed. This is the initial stage of mountain-building. Fractures also occur and give rise to earthquakes.

It can be mathematically found out that deformation produces much greater stress difference in thin crusts than in thick crusts. In the

case of a thin crust, the depressed regions are compressed above and stretched below and the elevated regions are stretched above and compressed below. Moreover maximum stress difference is liable to occur below the greatest elevation and the greatest depression. In the case of the Himalayas there is overloading in the foot-hills and considerable underloading further south in the Gangetic valley, and consequently this great anomaly causes very great stress-difference in this region. If the stress-still further increases, the crust at the point may not be strong enough to sustain it, and fracture may occur to relieve the tension.

It has been suggested that some disturbing extra-terrestrial cause may start the rupture by "trigger action" and that the conjunction of planets may be one such cause.

We find that the cumulative effect of all the planets, even at the time of conjunction, is much smaller compared to the effect produced by either the sun or the moon. So if there be any "trigger" action, it can most possibly be by the combined action of the moon and the sun when their effects are added up at the time of a new moon. In that case more earthquakes should occur at the time of the new moon than at any other time. But it is doubtful whether lunar periodicity really dominates the occurrence of earthquakes. It has also been suggested that earthquakes are more frequent by night than by day; but available data on this subject does not conclusively prove the above statement. It is also found that the lunar tide in the atmosphere which was first investigated by Chapman has very little effect on the occurrence of earthquakes.

M. N. SAHA.
*Allahabad University.*

In view of the great area over which this earthquake was felt, it seems unlikely that the focus of the earthquake was shallow as suggested by Dr. S. K. Banerji. Earthquakes which are known to have had a shallow focus, such as the Italian earthquakes, which occur in a volcanic region, although of great intensity at the epicentre, rapidly decreased in intensity away from the epicentre. But the reverse was the case in the Bihar earthquake, and it is likely therefore to have had a deep focus.

## Research Notes.

### Indian Musical Drums.

*The Proceedings of the Indian Academy of Sciences*, 1934, **1**, 179 contains a very interesting paper on "The Indian Musical Drums" by Sir C. V. Raman. The value of the paper is very much enhanced by the numerous photographs of the nodal lines of the various modes of vibration of the drum. As the author remarks, the Indian musical drum stands in a class by itself since in it an inharmonic sequence of notes has been ingeniously converted into a harmonic series, enabling the instrument to be employed in chamber music where ordinary percussion instruments would be intolerable. There are various varieties in the two chief forms, *viz.*, the Mridanga and the Thabla, the first of which is a barrel-shaped instrument with a drum-head on either side, while the second consists of two separate drums one to be played with each hand. The common feature of construction is the contrivance for adjusting the tension of the drum-head equally in all directions: this always consists of sixteen thongs attached at equal intervals round the drum-head, the tension being varied to a nicety either by means of wooden pieces which are struck by a mallet into different positions or in some later forms screws are used to vary the tension. The right hand drum-head is constructed in a peculiar manner, consisting as it does of three layers of drum-skin which in the final stages are cut out leaving only rings all round excepting for one drum-skin which is loaded in the middle with a firmly adherent composition said to consist of iron oxide, charcoal, starch and gum applied layer by layer so as to give the peculiar loading. The left hand drum-head is somewhat larger and is similarly constructed but without central loading. The note given out by these drums is a sustained one resulting from two features of construction, *viz.*, the heavy wooden shell on which the skin is stretched and the central loading. The gravest mode of vibration is that without interior nodal lines. The second is that having one nodal diameter, the third having two nodal chords dividing the drum into three parts; the fourth has three nodal chords while the fifth has four nodal lines and the drum-head is divided into five parts. These several modes of vibration form a harmonic series. The third harmonic is produced by a combination of the vibration with one nodal circle and that with two nodal diameters. The fourth harmonic is given by the mode with one nodal diameter and one nodal circle or by a mode with three nodal diameters or by a combination of the two modes. The fifth harmonic similarly arises from the mode having four nodal diameters or the

mode having a nodal circle and two nodal diameters. The paper gives details of exciting these various tones and is beautifully illustrated by sand figures formed on the vibrating drum-head.

T. S. S.

### New Elements beyond Uranium.

SOMETIME ago Fermi and his collaborators reported the results of their experiments on the production of new radioactive elements by bombarding various elements by neutrons. In the case of uranium they obtained a product which showed two main characteristic half-value periods, namely, 13 min. and 90 min. apart from other extremely short-lived (10 secs. and 40 sec.) components. Studying these main components, Fermi and his co-workers showed some evidence to believe that these represented new elements of higher atomic number than uranium. A. V. Grosse repeated their experiments and came to the conclusion that the reactions noted by the Italian scientists were to be attributed to element 91 and not to elements of higher atomic number than uranium. In *Die Naturwissenschaften* (1935, **23,** 37) Lise Meitner gives a preliminary account of her investigations regarding the nature of the 13 min. and 90 min. products. Details of the searching chemical analysis to which the products were subjected are given and the conclusion reached that the new products are not representatives of element 91 nor of any other element with lower atomic number. She also gives reasons to believe that the two products are not isotopes but are different elements. The opinion is expressed that the 13 min. product might be element 93 and the 90 min. product element 94. Further details are to be published elsewhere; we await them with interest.

T. S. S.

### The Carbonyl- or CO- frequency in Raman Spectra.

THE Raman spectra of 69 compounds of type X—CO—Y, including acid amides, ketones, crotonyl compounds, acid chlorides, urea, phosgene, etc., obtained with the same apparatus, and under almost identical conditions, have been subjected to a systematic study by K. W. F. Kohlrausch and A. Pongratz [*Z. physikal Ch.* (B), 1934, **27,** 176]. A preliminary analysis of the normal oscillations of a plane symmetric molecule of type $X-\overset{\overset{\displaystyle O}{\|}}{C}-X$, belonging to the symmetry group $C_{2v}$, shows that all the six modes $\omega_1$ to $\omega_6$ are both Raman and infra-red active, 5 being in the plane of the molecule. Three of these five are total symmetric ($\rho < 6/7$), and two anti-symmetric ($\rho = 6/7$). With the help of the approximate formulas for a valency force system, the observed lines for $NH_2$—CO—$NH_2$, $CH_3$—CO—$CH_3$, and Cl—CO—Cl, have been identified with these types of oscillations.

This identification of the lines could now be extended to unsymmetrical molecules of type X—CO—Y, by intrapolation (between X—CO—X and Y—CO—Y), and by extrapolation with progressive changes in X or Y. Here, although $\omega_1$ represents a mode of normal vibration of the whole molecule, it is predominantly determined by the C=O binding, and can be called the carbonyl or CO-frequency. The value of $\omega_1$ changes from compound to compound and it is shown that these changes are to a considerable degree due to the constitutive influences on the bond strength in C=O. When the carbonyl frequencies in all the compounds are systematically arranged, as in Table IV, pronounced regularities are observed. In order to obtain a still clearer view of these changes, the CO-frequencies are plotted with frequency as abscissa, and the substituents as ordinates, the scale for the latter being so chosen, that the CO-frequencies for the arbitrary case of R—CO—X, all lie in a straight line. It is to be expected that these graphs should all be parallel straight lines, if the influences of the groups X and Y superpose without any distortion. While this is generally observed, it is not always the case. The deviations from parallelism are, however, in the correct sense, and for the following reason. On the basis of existing information, the influence of the groups can be ascribed to the electrostatic fields due to them. Actually, in the scale adopted here, the groups have roughly arranged themselves in the order of their dipole moments, from the —$NH_2$ with the highest positive moment at one end to the —Cl with the highest negative moment at the other. When the signs of the substituents are the same, the mutually induced additional moments in the substituents tend to decrease the original moments and therefore to decrease the influence on $\omega_1$. A quantitative consideration of the mechanism

of these effects is at present beset with almost insuperable difficulties.

M. A. G.

### A New Theory of the Glass Electrode.

DOLE was the first to explain the behaviour of the glass electrode in alkaline solutions. Considerations similar to those involved in the formulation of the liquid junction potential led to an equation which well expressed the experimental results. But the interpretation of the constants in the equation was possible only by assuming that $H^+$ has a mobility $10^{11}$ times as much as any other ion at the interface. Furthermore, the relative mobility appeared to change with concentration. Gross and Halpern (*J. Chem. Phys.*, 1934, **2**, 136) developed a theory based on the general distribution law. Dole *J. Chem. Phys.*, 1934, **2**, 862) has recently applied the quantum statistical theory of electrode processes developed by Gurney, to explain the glass electrode potentials. The equation derived is of the same form as the one derived on the basis of the liquid junction theory; but the constants involved receive a new and a more plausible interpretation. The new theory explains the inability of the anions to affect the potential. A critical review of the experimental data shows how the quantum statistical theory is superior to that of Gross and Halpern. An important feature of the new theory is the quantitative prediction of the temperature variation of the glass electrode potential, data regarding which are lacking at present and are of great interest from the point of view of the theory.

K. S. G. D.

### Surface Films.

THE study of films of organic substances on water has been recognised to be of utmost importance in elucidating the constitution and orientation of molecules on surfaces. Adam's improved type of surface pressure balance for the study of films of the "gaseous" type gives valuable information regarding the structure of the film. The measurement of surface potentials using an "air electrode" of a platinum wire coated with polonium placed above the film, has been extensively used in these studies. Adam and his co-workers have shown in a series of papers that a change in the orientation of molecules at a surface brings about a change in the surface potential. In a recent paper [*Proc. Roy. Soc.* (A), 1934, **147**, 491] Adam and others have worked with films of the "gaseous" type (Dibasic acid esters, long chain alcohols, aldoximes and ketones). $\mu$ (the average effective vertical component of the dipole moment of the surface film forming molecules) has been calculated from $\triangle V$ (the surface potential) using the equation due to Helmholtz

$$\triangle V = 4\pi n\mu$$

where $n$ is the number of mols. per sq. cm. of the film.

In the case of surface films of substances with two ethyl ester groups $\mu$ is a constant so long as the films are "gaseous". The $\mu$ for the ester group is much larger when the molecules lie flat than when standing on end. In the case of alcohols, ketones, etc., $\mu$ does not change much during the transition from the expanded to the condensed state, showing that the orientation of the end groups remains unchanged. The end groups are not re-oriented by the restricted oscillations of the chains as a result of the diminished free space available for them on compression.

M. P. V.

### Fungicidal Action of Elements in Relation to their Position in the Periodic System.

IN a highly interesting paper on the fungicidal action of elements (*Contr. Boyce Thomson Inst.*, 1934, **6**, 4) McCallan and Wilcoxon have compared the toxicity of a large number of compounds with regard to their effect on the germination of fungous spores. The method employed was to determine the concentration of the substance which permits 50 per cent. germination (LD 50) after 20 to 24 hours. Four species of fungi were used, *Sclerotinia americana* (Worm.) Nort. & Ezek., *Botrytis pæoniæ* Oud., *Pestalotia stellata* B. & C., and *Uromyces caryophyllinus* (Schr.) Wint. In spite of the several limitations incidental to a study of this character, the elaborate investigations of the authors have indicated several centres of toxicity in the periodic table. With a few exceptions the toxicity within a group increases with increasing atomic weight. The elements of the group yttrium, lanthanum and the rare earths are generally toxic and the more common ones in the group offer promise of a more general use as fungicides. Silver and osmium were the most toxic. The halogens and generally

the more negative elements exhibit wide differences in toxicity depending upon the type of compound tested; while with the more positive elements the same order of toxicity was observed regardless of the compound used. The volatile hydrides so far as tested are all highly toxic; and little toxicity is exhibited by the highly oxidised forms. An element which is highly toxic to one fungus tends to be also toxic to other fungi, a fair degree of correlation having been observed, for the order of toxicity of the different elements with the four fungi studied.

B. N. S.

### Heavy Minerals in the Tertiary Intrusives of Central Colorado.

IN recent times the study of heavy minerals for purposes of stratigraphical correlation is becoming more and more important. J. T. Stark (*Am. Mineralogist*, **19**, No. 12) in attempting to correlate the Tertiary intrusives of Central Colorado with the Princeton batholith, has subjected nearly 30 specimens from different localities to mechanical analysis. His table reveals a lack of variety in minerals, these are for the most part made up of apatite, biotite, pyrite, titanite, ilmenite and zircon, which are also the important heavy minerals in the Princeton batholith. The characteristic absence of minerals like tourmaline, fluorite, beryl and sillimanite show that the Tertiary intrusives were particularly poor in mineralisers, and were relatively 'dry' magmas. From these evidences he has confirmed the interpretation of Crawford made on the basis of petrographic studies and field relations that these intrusives must have had a common magmatic source—possibly related to Princeton batholith. From the study of numerous articles on heavy mineral separation and correlation which are so prominently appearing in current journals, it is not too much to expect that it will come in handy for confirming many of the correlations that have already been done on other slender evidences.

### The Mino-Owari Earthquake of 1892.

IN a short note to the *Geological Magazine* (Dec. 1934, 846) Charles Davison, the noted seismologist, has attempted to trace the effects of earthquakes on the condition of strain in the surrounding crustal regions. In some cases the strain is increased, whereas in other cases the strain is decreased. Such changes on the condition of the strain in the adjacent crust is sufficient in many cases to produce what Oldham has termed 'Sympathetic earthquakes'. This phenomenon has now been studied by Davison in detail in the case of the great Mino-Owari earthquake of 1891. Statistics show that after this great earthquake, in certain of the districts especially in 7 and 13 of Milne's map of Japan, the number of shocks increased suddenly because they are situated on the main fault line. Further by the study of the Milne's charts, Davison has been able to show that the effects of the movement producing 'Sympathetic earthquakes' were confined to within a distance of about 100 miles.

### The Cytology of the Alimentary Canal of Periplaneta.

R. A. R. GRESSON has described (*Q.J.M.S.*, December 1934, **77**, Part II, No. 306) the form and distribution of the cytoplasmic inclusions and their relationship to the secretory granules in the epithelial cells of the midgut and hepatic cæca of *Periplaneta orientalis*. Functionally the hepatic cæca and the anterior region of the midgut are chiefly secretory while the posterior part of the midgut is main absorptive. In the anterior part of the midgut the periods of secretion alternate with the periods of absorption. Both the Golgi bodies and the mitochondria in the secretory as well as the absorptive cells are described with reference to their topographical relations to other organs of the cell and also to their shape. The author suggests that the secretory material is separated under the influence of mitochondria and in the vicinity of the nucleus is used in the formation of the secretory granules under the influence of the Golgi bodies.

### The Arterial System of the Common Indian Rat Snake.

HARISH CHANDRA RAY (*Journ. of Morph.*, December 1934, **56**, No. 3), has given a detailed account of the arterial system of *Ptyas mucosus* and has recorded certain interesting features. The author has noticed for the first time the origin of the œsophageal artery from the left systemic arch, the presence of two longitudinal trunks on

either side of the hepatic portal vein and the formation of a peculiar looped chain. A separate splenic artery and the presence of a complicated arterial circuit in connection with the female reproductive organ and a pair of small arteries called "the arteria complexa" are the other interesting features of this form.

## Science Notes.

*A Study of the Atmospheric Horizontal Visibility at Bangalore.* By A. Ananthapadmanabha Rao (*Science Notes of the Ind. Met. Dept.*, 1934, **5,** No. 60). Visibility observations taken at Bangalore during a period of two years at 8, 10, 12 and 16 hours have been analysed and the monthly, seasonal and annual variations of visibility frequencies have been determined. Visibility is generally fair to good; bad visibility is a rare occurrence except in the mornings, when it is largely associated with mist, fog or haze; the frequency of bad visibility is greatest in winter and summer reaching a maximum in March, and is least in the South-West Monsoon with a minimum in August. A study of the association of bad visibility with relative humidity, wind velocity, wind direction and Cumulus or Cumulo-Nimbus clouds, shows that:—(1) bad visibility is a minimum with values of relative humidity between 61 and 80 per cent.; (2) frequency of bad visibility decreases with increase in the velocity of the surface-wind; (3) bad visibility is most frequent with southerly winds and least frequent with northerly winds; and (4) bad visibility is less frequent in the presence of Cumulus or Cumulo-Nimbus clouds than in their absence.

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*The nature and germination of seeds of* Tinospora cordifolia *Miers.*—Messrs. S. L. Ajrekar and J. D. Oza of the Gujarat College, Ahmedabad, write: "With reference to the note on fruit and seed development in *Tinospora cordifolia* Miers. without fertilisation and embryo formation published by A. C. Joshi and V. V. Raman Rao (*Curr. Sci.*, 1934, **3,** 62) and the subsequent note on Exembryonate seeds by B. Sahni (*Curr. Sci.*, 1934, **3,** 109) it may be of interest to record that in the course of an investigation of the fungus parasites of *Tinospora cordifolia* Miers. which we have been carrying out at Ahmedabad we have had occasion to raise seedlings of this plant for inoculation experiments and we have found that the seeds have a normal embryo and the germination is also perfectly normal.

The non-formation of an embryo noted by Joshi and Rao is probably only due to the absence of pollination. This point can be easily settled by them by artificial pollination. The question of the germination of the exembryonate seeds can also be answered by them by actual trial.

The development of "barren" fruit without the stimulus even of pollination is a familiar phenomenon in cultivated plants, *e.g.*, in Fig, Cucumber, Grape.

* * *

*A note on seed variations in* Carica papaya, *Linn.*—Mr. S. A. Parandekar, M.Sc., Rajaram College, Kolhapur, writes under date 9-2-1935: "The usual experience of many of us is that the mature fruit of Papaw (*Carica papaya*) contains numerous black seeds filling up as it were the cavity of the fruit. All these seeds are very nearly alike. Very interesting types of variations in the sizes and the number of these mature ovules have been observed.

"In one of the ripe fruits only two seeds of the usual form and size were found. In another fruit belonging to the same plant only one ovule of an abnormal size (about ½") and of a yellowish colour was found. This could not in any way be differentiated into the parts of a seed. The micropyle was wide open and the integuments prominently seen. A naked eye examination of the longitudinal section, however, failed to show any differentiation in the nucellar tissue which simply represented a large mass of cells; in a third fruit of the same plant an ovule of the type mentioned above was present in addition to a few (about 10) normal seeds."

* * *

*Rare Observation of a Plant drawing Nourishment from Eggs.*—Mr. A. Ramakrishna Reddy, B.Sc. (Hons.), of the Annamalai University, reports a rare observation concerning a well-developed grass plant of the genus *Cyperus* in the University grounds whose roots had pierced three developing *calotes* eggs lying at different levels. Apparently the plant was drawing its nutrition from them. The plant had also developed adventitious roots in the lower and middle eggs, both of which had shrivelled down owing to their being depleted of the contents. The observer considers this to be a case of semi-parasitism or a rare and unusual instance of a plant developing a carnivorous habit through the root system.

* * *

*Map-making in India.*—From the first attempts at Map making made by the Merchant Adventurers of old to the rigorous methods of surveying introduced first by Col. Lambton (1800-1823) and extended and improved by Col. Sir George Everest (1830-1843), the history of Indian surveys is one of evolutionary progress. The first map of India appears to have been prepared by the French Geographer D'Anville from a knowledge derived by the routes of travellers in India and rough charts of the coasts; the English Edition of this was published in 1764.

The credit for laying the real foundation of Indian Geography goes to Major James Rennell (1763-1782) who as Surveyor-General of Bengal carried out systematic route surveys, the specified stations being located by means of astronomical observations of longitude and latitude. The Bengal Atlas published in 1781 was the result of his labours. About the year 1800, Major Lambton, who realised the inaccuracy of the older methods, put up proposals for carrying out a scientific trigonometrical survey. The work of covering the whole of India with a grid of accurately measured triangles has been continued ever since, and the credit of planning and mapping of India on a really scientific basis goes to Lambton. His able successor Sir George Everest started

on the completion of the Great Meridional Arc series of triangles which had been brought up from Cape Comorin to Sironj in the centre of India, and was to terminate in the Himalayas near Mussoorie. Up till 1843 he was employed in extending his system of a gridiron of triangulation in the series about 60 miles apart which was opposed to Lambton's scheme of a network. The whole conception of the basis of land surveying in India, as it now exists, is due to the creative genius of Sir George Everest (1830-1843).

* * *

*Third International Congress of Soil Science.*—The Third International Congress of Soil Science will be held in Oxford, England, from July 30th to August 7th this year under the presidency of Sir John Russell, D.SC., F.R.S. The two previous congresses of the series were held in Washington in 1927 and in Leningrad and Moscow in 1930, and were notable for the exceptionally international character of the personnel and the discussions. The Congress will meet as a whole in six plenary sessions, at which a general survey of recent advances in every branch of soil science will be made, and it will also work in sections or "Commissions" dealing specifically with soil physics (I), chemistry (II), biology (III), fertility (IV), classification (IV) and technology (VI). Three sub-Commissions will discuss problems relating to alkali, forest, and peat soils respectively. A 16-days excursion round Great Britain leaving Oxford immediately after the Congress, and terminating in Cambridge on August 23rd is being arranged for the benefit of members wishing to obtain first hand knowledge of British agriculture and soils.

Every member of the Congress will receive a copy of the Official Transactions, including the full text of papers read at the plenary sessions, and detailed reports of the discussions at the Commission sessions. The cost of the Transactions will be included in the Congress fee (£ 2), payment of which will also entitle members to attend all meetings, receptions, etc., held in connection with the Congress. Accommodation during the Congress in an Oxford College may be reserved through the Organising Committee, or privately in hotels or boarding houses.

Intimation of attendance at the Congress should be sent as soon as possible to the Secretary of the Organising Committee, Mr. G. V. Jacks, Imperial Bureau of Soil Science, Harpenden, England, from whom all further information may be obtained.

* * *

*Fourth International Fertilisers' Conference.*—We are happy to announce that Prof. N. R. Dhar, D.SC. (London and Paris), F.I.C., I.E.S., Professor of Chemistry, University of Allahabad, has been appointed National Correspondent for India of the Fourth International Conference which will be held at Rome in 1936. Prof. Dhar has accepted the office and will be proceeding to Rome next year. This International Organisation has branches all over the world and the National Correspondents are expected to report to the Conference the Agricultural Progress of the Country which they represent. Dr. Franco Angelini, Member of the Italian Parliament, is the Secretary of the Conference.

* * *

*New Oil Seeds Research Station in Madras.*—About fifteen acres of land were leased in 1925 for research on groundnuts. In 1930, Government sanctioned the mobilisation of a separate section for research on important oil seeds, *viz.*, Groundnuts, Gingelly, Castors and Cocoanuts. The increased work demanded a larger station but there were no possibilities for extending the existing station, and it was therefore decided to open a new station about a mile and six furlongs away from Tindivanam (South Arcot District) in the heart of the groundnut area. The new station is about fifty acres in extent with possibilities for expansion, if necessary. A sum of about Rs. 25,000 is sanctioned for the purchase of land, necessary equipment and construction of residential buildings. The Imperial Council of Agricultural Research has sanctioned a scheme costing about Rs. 50,000 for research on oil seeds in Madras. The research work proposed under this scheme will be conducted on this station. Genetical, physiological and agronomic problems connected with groundnuts, gingelly and castors will mainly be dealt with at this station.

* * *

The Academic Council of the Aligarh Muslim University has decided to award the degree of Doctor of Philosophy—the first Doctorate given in Physics by the University—to Mr. Muhammad Zaki Uddin, M.SC. HONS. (Alig.), Research Scholar of the Aligarh Muslim University.

* * *

*Indian Central Cotton Committee.* The 30th meeting of the Indian Central Cotton Committee was held on the 4th and 5th February 1935, at the headquarters of the Committee at Vulcan House, Nicol Road, Ballard Estate, under the presidency of Diwan Bahadur Sir T. Vijayaraghavacharya, K.B.E., Vice-Chairman, Imperial Council of Agricultural Research.

Among the more important subjects that came up for consideration may be mentioned a reference from the International Federation of Master Cotton Spinners' and Manufacturers' Associations suggesting a reversion to the original system of marking bales on hoops; complaint from the Lancashire Indian Cotton Committee regarding the mixing of different types of cotton; report of the Publicity and Propaganda Officer; findings of the Special Meeting of the Agricultural Research Sub-Committee on the schemes of the Committee; spread of Garrow Hill or Deorwada cotton in Berar; the establishment of cotton markets in the Bombay Presidency and the Punjab and the reports of Sub-Committees.

The Committee adopted the report of the Agricultural Research Sub-Committee. The Madras Pempheres and Physiological Scheme was examined in detail and its continuance agreed to.

The Madras Herbaceum Scheme was extended for a further period of three years for the further testing of promising strains. The Punjab Root Rot Scheme, the Punjab Botanical Scheme and the Punjab Spraying Trials Scheme were extended for various periods. A new scheme known as the Mysore 'Red Leaf Blight' Scheme was sanctioned for three years with a grant of Rs. 2,814 per annum. The Sub-Committee also recommended that the existing arrangement for subsidising the Hubli and Gadag Co-operative Societies be

continued for one more year at an estimated cost of Rs. 19,000. This was adopted.

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*Chronica Botanica—International Year-Book of Botany.* This work which is expected to be published in the Spring of 1935 embodies several important sections: (1) Calendar—important dates connected with the History of Botany and the activities of the well-known Botanists. (2) The International Botanical Congress Announcements, Reports of Proceedings, etc. (3) International Societies, Committees, Congresses, etc. (4) Survey of Pure and Applied Botany during the preceding year. This section will contain personal information about botanists in every part of the world and also annual reports of all botanical institutions including laboratories, museums, herbaria, experimental and other stations for applied botany. The nature of the more important investigations being carried on in these institutions will also be indicated. (6) Correspondence. This "Forum Botanicum" will provide opportunities for ventilating the views on all subjects of interest to botanists. (7) Advertisements. This Year-Book is edited by Fr. Verdroon in collaboration with an Advisory Board and numerous assistant and corresponding Editors. Further information can be obtained from Fr. Verdroon, Botanica, P.O. Box 8, Leiden, Holland.

* * *

*Association of Economic Biologists.*—5th January 1935:—Dr. R. D. Rege, Crop Physiologist, Padegon, gave a lecture on the "Problems of the Deccan Canal Tract".

At the annual meeting of the Association on the 23rd January 1935, the following office-bearers were elected: Mr. K. Ramiah, M.Sc., Paddy Specialist to the Government of Madras, *President*; Mr. V. Ramanathan, L.Ag., Cotton Specialist to the Government of Madras, *Vice-President*; and Dr. J. S. Patel, M.Sc. Ph.D., Oil Seeds Specialist to the Government of Madras, *Secretary*. The resolutions were passed, opposing the removal of valuable Botanical specimens from this country. The Retiring President, Mr. N. L. Dutt, Second Sugarcane Breeder, Imperial Cane Breeding Station, Coimbatore, delivered a very able address on "Recent advances in Sugarcane Breeding in India," illustrated with lantern slides.

28th January 1935:—Dr. J. A. Daji, Officer in charge of Soil Research, Sholapur, delivered a lecture on the "Decomposition of the green manure in soils".

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*Indian Botanical Society.*—At the annual meeting of the Indian Botanical Society held at Calcutta on January 4th, 1935, the following office-bearers were elected.

*President* (1 year): Dr. J. H. Mitter, M.A., Ph.D., F.L.S.: *Vice-Presidents* (1 year): Prof. P. Parija, M.A., I.E.S; Dr. S. R. Bose, M.A., D.Sc., F.L.S., F.R.S.E.; *Honorary Secretary* (3 years): Dr. E. K. Janaki Ammal, M.A., M.Sc., D.Sc., F.L.S.; *Members of the Executive Council* (1 year): (1) Dr. B. Sahni, M.A., D.Sc., Sc.D., F.G.S., F.A.S.B.; (2) Dr. P. C. Sarbadhikari, M.A., Ph.D., D.Sc., D.I.C.; (3) Dr. P. Maheshwari, M.Sc., D.Sc.; (4) Dr. T. Ekambaram, M.A., Ph.D. (5) Dr. M. A. Sampathkumaran, Ph.D.; (6) Prof. R. H. Dastur, M.Sc., F.L.S.; (7) Dr. S. P. Agharkar, M.A., Ph.D., F.L.S.; (8) Dr. K. C. Mehta, M.Sc., Ph.D.; (9) Dr. K. Bagchee, M.Sc., D.Sc., D.I.C.; (10) Mr. K. Biswas, M.A. Particulars regarding membership may be obtained from the Secretary, Dr. E. K. Janaki Ammal, M.A., D.Sc., Imperial Sugarcane Station, Lawley Road P. O., Coimbatore. Subscriptions for membership should be sent to the Treasurer and Business Manager, Prof. M. O. Parthasarathi Iyengar, M.A., Ph.D., F.L.S., Director, University Botany Laboratories, Teynampet, Madras.

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*Biochemical Society, Calcutta.*—A meeting of the Biochemical Society, Calcutta, was held on Wednesday, the 30th January, at the School of Tropical Medicine at 4-45 p.m. Dr. N. R. Chatterjee *et al* read a paper on "The effect of bacteriophage on the enzyme activity of vibrio choleræ" and Dr. B. C. Guha and Mr. A. R. Ghosh read a paper on "The biological synthesis of ascorbic acid (Vitamin C.)"

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The Executive Council of the Lucknow University has nominated Dr. Birbal Sahni of the Lucknow University as delegate to the third centenary celebrations of the Natural History Museum, Paris, which is being held about the last week of June 1935. Dr. Birbal Sahni will also represent the Lucknow University at the International Botanical Congress which is being held at Amsterdam in September 1935.

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*Proceedings of the Association of Economic Biologists, Coimbatore, Vol. I*, 1930-33.—This little pamphlet of about 100 pages contains an account of the transactions of the Association since the date of its inception in 1930. The activities of the Journal which were being recorded from time to time in the pages of the *Madras Agricultural Journal* have now been brought together within the covers of one volume in chronological sequence. The pamphlet represents a useful collection of abstracts of papers and lectures and since a good number of the observations communicated in abstract form does not appear to have been published as full scientific papers in any of the scientific Journals, this publication will form the only record of such observations. It is a matter for the publishers to consider whether in subsequent publications, it would not serve a more useful purpose if the contributions are grouped together under crop heads rather than arranging them in chronological sequence. Such an array will form a record of the progress of research under classified subjects. The abstracts, too, could be made fuller so as to include significant data.

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We are very happy to congratulate Dr. H. Chaudhuri, Ph.D., D.I.C., on his appointment as the Head of the Department of Botany Teaching in the University of the Punjab. The mantle of the late Rai Bahadur Shiv Ram Kashyap has fallen on worthy shoulders and we look forward for further progress in the department which has already a great reputation as research and teaching centre in India.

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We acknowledge with thanks the receipt of the following:—

"Journal of Agricultural Research," Vol. 49, No. 8.

"Journal of Agriculture and Live-stock in India," Vol. 4, Pt. VI.

"The Journal of the Royal Society of Arts," Vol. 83, No. 4287.

"Indian Journal of Agricultural Science," Vol. 4. Pt. VI.

"Contributions from Boyce Thomson Institute," Vol. 6, No. 4, Oct.-Dec. 1934.

"American Journal of Botany," Vol. 21, No. 10.

"The Journal of Institute of Brewing," Vol. 41, No. 1, Jan. 1935 and Supplementary Number containing title page, contents, Index, 1934, Vol. 40.

"Canadian Journal of Research," Vol. 2, No. 6.

"Chemical Age," Vol. 31, Nos. 808-809; Vol. 32, Nos. 810-812.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 67, No. 13, Vol. 68, No. 1.

"Journal of Indian Chemical Society," Vol. 11, No. 12.

"Indian Forester," Vol. 61, No. 1.

"Forschungen und Fortschritte," 11, Jahrgang, Nos. 1-3.

"Forest Bulletin, No. 87, 1934 (Silviculture Series) Von Wulfing's Yield Tables for Teak Plantations in Java," by H. G. Champian.

"Forest Bulletin, No 89, 1934. The Effect of Defoliation on the Increment of Teak Saplings," by H. G. Champian.

"Agricultural Statistics for India," Vol. 2, 1931-32. Area, Classification of area, Area under irrigation, Area under crops, Live-stock and Land Revenue assessment in certain Indian States.

"Transactions of the Mining and Geological Institute of India," Vol. 29, Pt. 3, December 1934.

"Indian Trade Review," Vol. 13, Nos. 73 to 74.

Department of Commercial Intelligence and Statistics in India—Statistical abstract for British India with Statistics where available relating to certain Indian States from 1922-23 to 1931-32.

Lanolin Rust Preventers (2nd Edition). Issued by the Department of Scientific and Industrial Research, Engineering Research Special Report No. 12. (H. M. Stationery Office, 1934.)

National Research Council, Canada, 17th Annual Report containing the report of the President and Financial Statement, 1933-34.

"Medico-Surgical Suggestions," Vol. 3, No. 12; Vol. 4, No. 1.

India Meteorological Department, Scientific Notes, Vol. 5, No. 60. A study of the Atmospheric Horizontal Visibility at Bangalore.

"Journal of the Indian Mathematical Society," Vol. 1, No. 3.

"Nagpur Agricultural College Magazine," Vol. 9, No. 2.

"Nature," Vol. 134, Nos. 3399 to 3400; Vol. 135, Nos. 3401 to 3403.

"The Journal of Nutrition," Vol. 8, No. 6.

"The Journal of Chemical Physics," Vol. 2, Nos. 11 and 12; Vol. 3, No. 1.

"Journal de Chimie Physique," Tome 31, No. 9.

"Physica," Vol. 2, No. 1, January 1935.

"Science Progress," Vol. 29, No. 115.

"The Indian Trade Journal," Vol. 155, No. 1490; Vol. 116, Nos. 1491 to 1493.

Imperial Institute of Veterinary Research, Annual Report, 1934.

CATALOGUES.

Bailliere Tindall & Cox.—Publications in Medicine and Sciences, October, 1934.

Cambridge University Press, Cambridge Spring Books, January to July 1935.

# Academies.

## National Institute of Sciences of India.

At the first ordinary general meeting of the National Institute of Sciences of India held in the rooms of the Asiatic Society of Bengal, 1, Park Street, Calcutta, at 11 a.m. on the 8th January 1935, the papers mentioned below were read:

(i) "Synopsis of the Pre-Vindhyan Geology of Rajputana," by Dr. A. M. Heron, D.Sc., F.R.S.E. (ii) "Physiology, Bionomics and Evolution of the Air-Breathing Fishes of India," by Dr. S. L. Hora, D.Sc., F.R.S.E., F.A.S.B. (iii) "Problems of the Solar Corona," by Prof. M. N. Saha, D.Sc., F.R.S., F.A.S.B. (iv) Ionospheric Height Measurements at Allahabad," by Mr. G. R. Toshniwal (communicated by Prof. M. N. Saha). (v) "On the Electron Theory of Metals," by Dr. R. C. Majumdar, Ph.D., University of Lahore (communicated by Prof. M. N. Saha). (vi) "On Symmetrical Space with Minimum rate of expansion," by Prof. N. R. Sen. (vii) "New facts regarding infection of Citrus by *Colletotrichum glecsporoides*," by Dr. H. Chaudhuri, Lahore. (viii) "Synthetic Enzyme," by Prof. H. K. Sen and Mr. Sobhanlal Banerji. (ix) On the question of the Expansibility of Zero in the series of Legendre functions having non-integral parameters," by Prof. Ganesh Prasad. (x) "On the Cataphoretic Speed and Inorganic Colloids," by Prof. J. N. Mukherjee, Mr. S. G. Chaudhuri and Mr. B. N. Ghosh. (xi) "On Mon and Munda in India and beyond," by Dr. J. H. Hutton, C.I.E., M.A., D.Sc., F.A.S.B., I.C.S.

Physiology, Bionomics and Evolution of the Air-Breathing Fishes of India. By Dr. S. L. Hora, Zoological Survey of India. The freshwater fishes of ponds, pools and marshes in this country, as in the tropics generally, are subjected, as a result of the marked periodicity of the dry and wet seasons, to extreme conditions of drought for prolonged periods. The shallow waters become very foul and are often liable to complete desiccation. As a result a number of fishes have adapted themselves to aerial respiration, so that the deficiency in the oxygen contents of the water does not affect their lives to any very great extent.

The fresh-water air-breathing fishes of Bengal have been extensively studied since 1830 and have been the subject of considerable experimental work. Fishes kept in aquaria and prevented from coming to the surface to breathe air were "drowned" in the earlier experiments, but if a larger vessel is employed or the water is kept

thoroughly aerated, "drowning" does not occur in the majority of cases. Fishes like *magur* (*Clarias*) and *singi* (*Heteropneustes*) can live indefinitely under water provided suitable conditions for life are established. In *koi* (*Anabas*) and *saul* and *lata* (*Ophicephalus*) the air-chambers are in the form of cavities in the head so that when these fishes are subjected to "drowning" experiments, a certain amount of air is locked up in the chambers and the fishes die of asphyxiation. If, however, this air is squeezed out and replaced by water in some way, the fishes can live under water indefinitely provided the water is kept well aerated.

*Cuchia* (*Amphipnous*) is a highly specialised fish in which regular "lung-like" chambers are developed for breathing air. This specialisation makes it impossible for the fish to live indefinitely under water.

In the dry season, hill-streams become cut up into series of pools in which the oxygen content of the water falls considerably as compared with that of rushing torrents. Here again the fishes are forced at times to resort to aerial respiration.

In tidal creeks of the estuaries and of the sea-shore, the tide plays an important part in the lives of certain fishes, specially the shore-living gobies and blennies. At times they are immersed under water and breathe by means of their gills, while at other times they are left high and dry and at such times they must resort to ærial respiration.

It is thus seen that in India the evolution of air-breathing fishes has taken place in four different habitats: (i) Marshes and ponds, (ii) Hill-streams, (iii) Estuaries, and (iv) Sea-shores. The habit of breathing air seems to have been acquired independently by groups of species living under different environmental conditions and it seems that while the simplicity of a structure is no criterion of its low organization or primitive nature, its utility appears to be the sole guiding principle in its evolution.

Dr. B. Prashad mentioned that he had watched Dr. Hora's experiments, which were carried out in the laboratories of the Zoological Survey of India, and had made such suggestions as had occurred to him at the time. He added that Dr. Hora's results are faithful records of his observations and mark a considerable advance on our knowledge of the physiology of respiration of the air-breathing fishes of India. Dr. Hora's suggestions regarding the mode of origin of the air-breathing habit in the fishes of different habitats offer a very promising field for further work and it is hoped that future workers will try to elucidate the various factors operating in these habitats more precisely.

Professor P. R. Awati enquired if the author had done any work on the vascular system of the air-breathing fishes so as to correlate the structural adaptations with consequential modification in the blood supply to the respiratory organs. In reply Dr. S. L. Hora referred Professor Awati to a number of works already published on the vascular supply of these fishes and added that further morphological work is, at his suggestion, being carried out at Cambridge and Lucknow to amplify the author's experimental results.

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## Indian Academy of Sciences.

The Sixth Scientific Meeting of the Indian Academy of Sciences was held on the 26th January at the Indian Institute of Science, Bangalore. Sir C. V. Raman, KT., F.R.S., N.L., the President of the Academy, was in the Chair. 43 scientific papers representing various branches of science and communicated by scientists from all parts of the country were listed for discussion.

The following papers have been published in the 7th Number of the Proceedings.

### SECTION A.

S. BHAGAVANTAM AND A. VEERABHADRA RAO: *Distribution of Intensity in the Rotational Raman Spectra of Gases.*—The relation between the apparently different types of intensity distribution in the rotational Raman Spectra of Liquids and Gases is experimentally followed up by compressing $N_2O$ and $CO_2$ at temperatures below their critical point. The absence of a maximum in the rotational wing and concentration of intensity in the close neighbourhood of the Rayleigh line which are regarded as specially characteristic of the liquid state, are now also observed in gases, although at high pressures. M. RAMANADHAM: *The Principal Optical Polarisabilities of the Napthalene Molecule.*—A new method of evaluating the optic moments of a molecule based on a knowledge of the orientation of the molecules and the refractive indices in the crystalline state, is presented. THE LATE A. N. MELDRUM AND P. H. PARIKH: *Synthesis of Phenylacetic acids from Gallic acid and its Methyl ethers.* THE LATE A. N. MELDRUM AND P. H. PARIKH: *Synthesis of* m-*Hemipinic acid.*—A new synthesis starting from veratric acid is described. AZHAR ALI KHAN, P. N. KURIEN AND K. C. PANDYA: *The Condensation of Aldehydes with Malonic acid in the presence of Organic Bases. Part II. The Condensation of Salicylaldehyde.*—The effects of a number of organic bases other than pyridine and piperidine such as lutidine, quinoline, cinchonine, etc., are quantitatively studied. K. VENKATACHALIENGAR: *The method of finding the class-number and the structure of the class group of any algebraic field.* I. CHOWLA: *The representation of a Positive Integer as a Sum of Squares of Primes.* S. L. MALURKAR: *Effect of variation on the Transmission of Temperature Discontinuity.* B. RAMAMURTI: *Linear Complexes related to a Rational Norm Curve.*

### SECTION B.

HARI RAMAN BHARGAVA: *Contribution to the Morphology of* Eclipta erecta *Linn.* B. M. JOHRI: *Studies in the Family* Alismaceæ. *II. Sagittaria sagittifolia* L. COL. I. FROILANO DE MELLO: *A Contribution to the Study of the Blood Parasites of some Indian Birds.*—The following parasites of Indian birds found in Goa are described or recorded:—(1) *Herodias intermedius* Wagler: a *Giardia* abundant also in the intestine and which will be described later on; *Plasmodium herodiadis* n. sp.; *Hæmoproteus* n. sp.?; a *Microfilarium*. (2) *Gallinula chloropus* L. *Plasmodium gallinulæ* n. sp. (3) *Machlolophus xanthogenys* (Vigors): *Hæmoproteus machlolophi* (Plimmer, 1912). (4) *Chloropsis aurifrons davidsoni* Baker: *Plasmodium chloropsidis* (Scott, 1925); *Leucocytozoon chloropsidis* n. sp.; a *Microfilarium*. S. S. PATWARDHAN: *On the Structure and Mechanism of the Gastric*

*Mill in Decapoda. II.*—A Comparative account of the Gastric Mill in Brachyura.—The gastric mill is essentially typical in all cases of Brachyura examined. S. S. Patwardhan : *Nematodes from the Common Wall-Lizard* Hemidactylus flavoviridis (*Ruppel*).—Examination of the intestines of several specimens of the common wall-lizard *Hemidactylus flavoviridis* (Ruppel) revealed the presence of two species of Nematodes: (1) *Thubunæa asymmetrica* (Baylis, 1930); and (2) *Thelandros hemidactylus* sp. nov. a new species of the genus *Thelandros* Wedl. 1862. C. R. Harihara Iyer, G. S. Siddappa and V. Subrahmanyan : *Investigations on the Rôle of Organic matter in Plant Nutrition, Part VI. Effect of minute quantities of certain forms of organic matter on plant growth and reproduction.* Injection of minute quantities of certain organic extracts into mature sunflower plants led to not only better growth but also greatly increased flowering and seeding. The best results were obtained in the case of plants receiving extracts of yeast or farmyard manure. Comparative trials with inorganic salts which were fed directly to pot or plot cultured French beans or barley did not lead to any marked improvement.

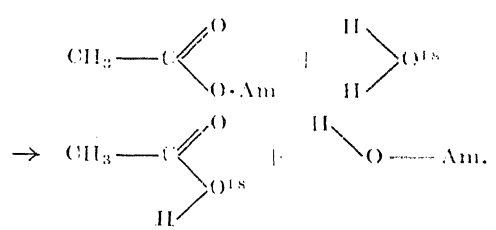
## Heavy Water in Chemistry.

In a lucid exposition before the Royal Institution, Prof. M. Polanyi (*Nature*, **135,** 19) points out that the new isotope of hydrogen is viewed so differently from other isotopes that some chemists consider its discovery to be possibly the greatest advance in chemistry made in this century. In fact this structural isotope does not behave as an isotope at all and can be separated from the normal hydrogen by chemical means. In general, compounds of heavy hydrogen (D) react more slowly than the corresponding ordinary hydrogen (H) compounds, heavy water reacting 20 times more slowly. These differences cannot be sufficiently accounted for as a mass effect. The compounds of the two hydrogens differ actually in their energy content, and this can be explained according to the Law of Uncertainty, a principle of Nature recently discovered by Heisenberg. According to this, every molecule has a kind of permanent energy called the "uncertainty energy", and it can be calculated that for ordinary water the energy is 13,097 cal., while for heavy water it is only 9527 cal. Thus ordinary water requires a much smaller quantity of energy to split it into hydrogen and oxygen than does heavy water. This permanent energy is greater the tighter the bond which holds the atoms in position and the corresponding contrast between the two hydrogen compounds also becomes more marked. The consequence is that D prefers to exchange places with H wherever it is more tightly bound, with a resulting release of some energy as in

$$HF + DI = HI + DF + 700 \text{ Cals.}$$

Such interchange reactions have been the object of numerous studies in recent years. According to the relative preference which a compound gives to D over H, a rather intimate knowledge of the permanent energies in the compounds is obtained. Further, this capacity of some compounds to accumulate a comparatively higher quota of D present in a mixture, can be utilised to work out a cheaper method of manufacturing pure $D_2$. The interchange reaction can be used to prepare more complicated compounds of heavy hydrogen, such as $C_6D_6$. It also throws a considerable light on the mechanism of chemical reactions, such as hydrogenation. Again, it may be possible to utilise the lowered reactivity in synthetic chemistry as hydrogen compounds which ordinarily are readily oxidised or otherwise decomposed,—might become more stable if H is replaced by D.

Heavy isotopes of other important elements, such as $O^{18}$, $N^{15}$, and $C^{13}$ can also be made similarly useful. Thus, the hydrolysis of amyl acetate with water containing $H_2O^{18}$ and examination of the OH of the resulting alcohol showed that the oxygen in the alcohol does not come from the water used in the saponification and the actual reaction mechanism is



It is likely that the greatest stimulus of all will be given to the chemistry of living matter when such labelled carbon, hydrogen, oxygen and nitrogen atoms will become more generally available.

M. A. G.

# Industrial Outlook.

## The Industrial Manufacture of Absolute Alcohol—I.

By Jean Caupin,
*Engineer, The Mysore Sugar Co., Ltd., Mandya.*

IT is well known that absolute alcohol cannot be obtained by mere distillation even from its very strong aqueous solution although the most efficient still-heads are employed, the reason for this being that alcohol and water form an azeotropic mixture which behaves like a pure liquid and is more volatile than pure alcohol. The constant-boiling mixture contains about 4.5 per cent. of water (Table I). The usual laboratory methods of preparing small quantities of absolute alcohol by treatment of dilute alcohol with solid drying agents like lime, calcium chloride, calcium carbide, calcium metal or potassium carbonate are uneconomic when practised on a large scale owing to poor yields and high cost of the drying agent. The most successful industrial methods are based on the valuable observations of Sydney Young[1] and his collaborators, the data obtained by whom are given in Table I.

Sydney Young discovered that when a mixture of equal weights of benzene and 95 per cent. alcohol are distilled, a ternary azeotropic mixture containing alcohol, benzene and water is formed, this mixture being more volatile and also richer in water

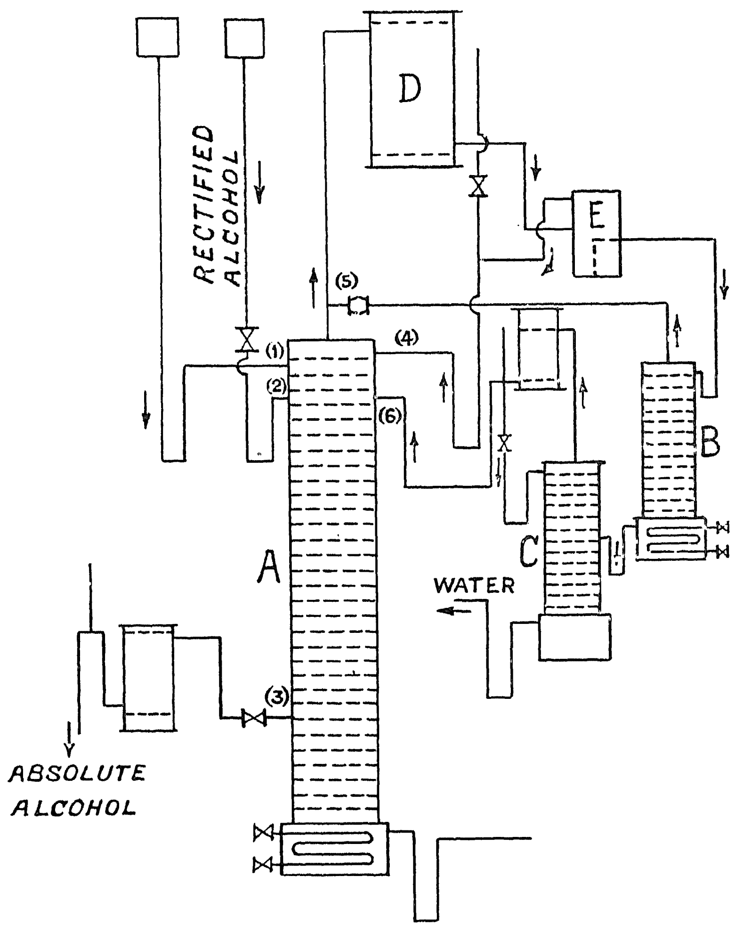



Fig. 1.

[1] *Distillation Principles and Processes*, 1922, p. 179.

TABLE I.

*Boiling Points and Percentage Composition of Alcohol, Benzene and Water Mixtures.*
(A=Alcohol. B=Benzene. W=Water.)

| Liquid | Boiling pt. | Percentage Composition | | |
|---|---|---|---|---|
| | | A. | B. | W. |
| W .. | 100 | | | |
| B .. | 80.2 | | | |
| A .. | 78.3 | | | |
| *Mixtures:* | | | | |
| A-W .. | 78.15 | 95.57 | .. | 4.43 |
| B-W .. | 69.25 | .. | 91.17 | 8.83 |
| A-B .. | 68.24 | 32.36 | 67.64 | .. |
| A-B-W.. | 64.86 | 18.5 | 74.1 | 7.4 |

than the alcohol-water mixture. It is therefore possible to expel all the water from 95 per cent. alcohol by adding to it a suitable quantity of benzene and carrying out a fractional distillation. During the distillation, there is a tendency towards formation of three fractions, all the water and benzene and some alcohol going over in the first two fractions, while the third fraction or residue consists of anhydrous alcohol. The distillate separates into two layers, the upper layer forming roughly 85 per cent. of the total volume. The composition of the two layers is as given below in Table II.

TABLE II.[2]

| | Water | Benzene | Alcohol |
|---|---|---|---|
| Upper Layer .. | 0.5 | 84.5 | 15.0 |
| Lower Layer .. | 32.0 | 11.6 | 56.4 |

With the help of the above introduction it will be easy to visualise the large-scale plant shown in Fig. 1, and its operation. Rectified alcohol is conveyed by the pipe (2) to the top of the distilling column A which is heated by a steam coil at the base. The binary azeotropic mixture which is formed fills the top of the column and flows back into it from the condenser. Benzene is now introduced gradually (pipe 1) in order to form the ternary mixture until the temperature in the middle of the column falls by 2-3° in the process. The column being thus prepared for dehydration the rectified alcohol is now fed continuously into it. Part of the liquid condensed in cooler D is sent to the separator E where it separates into two layers having the composition shown in Table II. The upper layer which is rich in benzene is sent back to the main column A in order to form more of the ternary mixture, while the lower layer flows into the subsidiary column B where the benzene in it is removed as the ternary mixture and transferred to column A. The dilute alcohol flowing from the base of column B is introduced into the rectifying column C, where it is resolved into 95.5 per cent. alcohol which is conveyed to the main column A. The water separated at the base of the column is thrown out of the system. In the main column A itself, the dilute alcohol descends from plate to plate and parts with its water to benzene which carries it away to the top of the column. Anhydrous alcohol completely free from benzene accumulates in the base of the column and is drawn off by a syphon device.

Some technical details regarding the process will not be out of place in this article, in view of the fact that the Mysore Sugar Co., Ltd., Mandya, are erecting a plant supplied by the French firm who have arrangements with the owners of the patent rights, the "Usines de Melle", for manufacture of the required plant. The said firm, *viz.*, "Ateliers Pingris and Mollet-Fontaine à Lille, France" have erected several plants in various parts of Europe including Germany. More than a hundred millions of gallons of absolute alcohol are being prepared every year by this process, one particular factory having a capacity of 40,000 gallons of absolute alcohol per day.

Several modifications of the plant are available to operate it to produce (1) liquors like arrack and rum for human consumption, (2) rectified spirits, or (3) absolute alcohol.

The question of the production of industrial alcohol for purposes of power-raising has received considerable attention in recent years owing to the enormous quantities of molasses available in sugar factories, which, unless utilised, threaten to paralyse the sugar industry. Considering the low price of the molasses and the efficient processes available for manufacture of absolute alcohol, one can expect to see a Power-Alcohol industry firmly established in India in the near future.

The author will be pleased to furnish additional information on any points of obscurity either in the technical or industrial aspects presented in this paper.

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2 Guinot, *Chime and Industrie*, 1926, 15, 325.

# Reviews.

UNE NOUVELLE CONCEPTION DE LA LUMIÈRE. By Louis de Broglie. (Hermann et cie, Paris.) Pp. 48. 12 Francs.

This monograph deals with a new theory of light by M. de Broglie. Presenting an outline of the theory of the corpuscle of Dirac, he has examined the electromagnetic operators, the potential and the field attached to it. Then he has postulated that the photon exists as a corpuscle of Dirac obeying the Wave Equation. He shows thereby that the photon is made up of two elementary corpuscles with a spin $\frac{h}{4\pi}$ for each and obeying the Bose-Einstein Statistics. A very interesting feature of de Broglie's 'demi-photon' is that its rest mass is not rigorously zero (as in his old theory) but is of the order $10^{-44}$ gms., *i.e.*, $10^{16}$ times smaller than that of the electron.

N. S. N.

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ATOMIC THEORY AND THE DESCRIPTION OF NATURE: Four Essays, with an Introductory Survey. By Niels Bohr. (Cambridge University Press, 1934.) Pp. 119. Price 6*s*.

We have in the book before us a collection of four essays by Niels Bohr with an introductory survey which serves to emphasise the unity of thought running through the several essays. These essays appeared at different times in different journals and each served to orient physical thought and lead it to fresh conquests. The present collection thus helps us to have a glimpse into the forces which resulted in the extraordinary developments of Quantum and Wave Mechanics.

The first essay is an elaboration of a lecture delivered in August 1925 before the Scandinavian Mathematical Congress at Copenhagen and stresses the Mathematical methods used in the development of Quantum Physics. The second is expanded from a paper read before the Como International Congress of Physicists in 1927 and lays emphasis on the indeterminacy principle and the complementarity of the wave and particle pictures. The third was published in 1929 as a contribution to a pamphlet issued to commemorate the jubilee of Planck's doctorate and emphasises the subjective character of our perceptions and inferences. The fourth article is developed from a lecture delivered before the Scandinavian Meeting of Natural Scientists in 1929 and considers the relation between the concepts evolved from a study of inanimate Nature and those necessary to understand the phenomena of life. In this last essay Bohr shows that the indeterminacy which crops up when extremely small-scale atomic phenomena are studied may be characteristic of the processes of life itself. Bohr has been at the head of the younger school of physicists who have decided that causality has to be sacrificed in order to have a rational description of Nature and we see in these essays a masterly exposition of this viewpoint. The articles also give a survey of the development of modern quantum theory with a keen analysis of the implications of these developments. The publishers deserve thanks for making these essays available to a larger public.

T. S. S.

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INTRODUCTION TO MECHANICS AND HEAT. By Nathaniel H. Frank, SC.D. (McGraw-Hill Book Company, Inc.) Pp. xiv + 339. Price 18*s*.

The book is an attempt to develop a unified treatment of Mechanics, Accoustics and Heat. A logical development starting with the dynamics of a particle, leading up to that of a rigid body and a system of particles occupies the first twelve chapters. The treatment is detailed, and includes a study of such topics as simple harmonic motion, the pendulum, gyroscopic motion, and gravitational motion, as also the principles of statics. Vector concepts are freely used and elementary calculus employed wherever needed. Chapter XIII on Hydrostatics includes a short treatment of surface tension and Chapter XIV on Fluid Dynamics a similar short treatment of viscosity and flow through pipes. A concise treatment of elasticity in Chapter XV is followed by accoustics in Chapter XVI under the suggestive title "Dynamics of Elasticity". The rest of the book, Chapters XVII-XXII are devoted to Heat, and deal with heat conduction, the thermodynamics and kinetic theory of a gas, properties of real gases and the laws of thermodynamics.

The whole subject-matter is dealt with purely on the theoretical side, and no attempt has been made to deal with or describe the experimental side. The treatment is lucid, and the book is eminently calculated to give a consistent and logical theoretical grounding

in the main principles of the subjects dealt with to a pass degree standard. A feature is the number of examples worked out and the large list of problems given at the end of most of the chapters.

A. V. T.

* * *

TORSIONAL VIBRATION, ELEMENTARY THEORY AND DESIGN CALCULATIONS. By W. A. Tuplin, M.Sc. (Chapman & Hall, Ltd., London.) Pp. xviii+320. Price 21*s*.

This is a book of very great interest to the mechanical engineer who has to deal with the design of shafts for the transmission of power, whether in automobiles, aeroplanes or ships, where power is either communicated to or absorbed from the shaft periodically and the transmitting system is capable of torsional vibrations. It is obvious that under these conditions dangerous oscillations involving high stresses in the materials of the shaft may arise leading to breakdown. That a whole book should be devoted to what may appear at first sight a very narrow branch of Physics shows the degree of importance which such topics often assume to the technician.

The subject-matter is dealt with in a very practical manner both on the theoretical side and in its applications. Chapters I, V and IX deal with the basic theory of torsional vibrations, solutions of numerical equations and the harmonic analysis of periodic torques respectively. The rest of the Chapters I-X take up the problems of free and forced vibrations of shafts loaded with single, double and multiple masses, in a progressive manner with a wealth of illustrations and numerical calculations. Chapters XI-XIII deal with the critical speeds of such systems, their resonance under periodic fluctuations of torque, the resulting stresses and methods of damping such systems to avoid dangerous stresses being set up. The rest of the book deals with such special subjects as geared systems, heavy shafts, couplings and impulsive torques.

A bibliography containing 28 references, a two-page index and a table explaining the symbols used to designate the several physical quantities involved with the units adopted for measuring them, are noticeable features. The get-up of the book is very good.

A. V. T.

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THEORY OF ALTERNATING CURRENT WAVE FORMS. By Philip Kemp. (Volume I in "Monographs on Electrical Engineering" Series published by H. P. Young.) (Chapman & Hall, Limited, 1934.) Pp. ix+218. Price 15*s*. net.

The advances in electrical engineering within recent years have been so rapid that literature on many subjects has lagged considerably behind knowledge on these subjects and one has to wade through a mass of matter scattered in the technical literature to get a comprehensive idea of these subjects. Therefore the publication of the "Series of Monographs on Electrical Engineering" of which the present book is the first volume is very much to be welcomed.

The book begins with a comprehensive treatment of the properties of complex waveforms in which their effect on impedance, resonance conditions, power, power factor, form factor, etc., have been clearly explained. This is followed by wave and ripple filters, polar diagrams, and power and energy cyclograms. The very interesting subject of the effect of iron has been dealt with in a separate chapter followed by another chapter on cyclically varying resistances, areas and pulsating reactance and capacitance as sources of harmonics. Harmonics in polyphase systems have been treated in a separate chapter, but in view of its extreme practical importance one would have liked to see an ampler treatment of this subject. The book ends with a chapter on the various methods of harmonic analysis. No mention has been made of transients. In view of its great importance, particularly in transmission line work, the inclusion of a chapter on surges would have considerably increased the value of this book.

The book should be equally useful to the advanced student and the engineer and its companion volume on "Alternating Current Wave Forms in Practice" by the same author, which is in preparation, will be looked forward to with interest by the reader of the present volume.

F. N. M.

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AUTOMATIC PROTECTION OF A.C. CIRCUITS. By G. W. Stubbings. (Chapman & Hall, Ltd., London.) Pp. 293. Price 15*s*.

Recent practice in the distribution of Electricity has been effected through a net work of distribution system so that the least possible delay occurs in restoring service during interruptions and also that almost all the consumers have the chances of alternative supply and interruptions are reduced to a minimum. Even in the high tension

transmission line, several stations are being tied together to ensure continuity of supply. The above procedure has brought in a number of interesting problems with regard to the protection to be afforded for various distribution centres as well as the generating stations thus inter-linked with the result that various kinds of protective relays have been developed and the distribution and station Engineer should have a thorough knowledge of these relays and their operation to correctly synchronise them so that they function accurately to the best advantage of the engineer, machinery and the consumer. The function of these relays is entirely dependent upon the instrument transformers which are the source of supply of energy to these relays and these transformers are of a special nature and should possess special characteristics to be of efficient service.

In the above book which has been very lucidly written the author has made a sincere attempt to explain the essential points and the characteristics of these transformers to enable the reader to grasp correctly their functions and thereby understand the functions of the relays connected therewith. Even though the book may not be titled as a treatise on all the types of relays developed recently, it certainly gives a fairly good idea of the various types and the duties that each apparatus and particularly the characteristics of each kind of relay have been brought out very well to enable any engineer to follow their functions and utilise them to his best advantage. The explanations have been narrative as well as Mathematical just enough to indicate their functions and are, I believe, within the understanding of an ordinary engineer.

M. H.

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CLINICAL AND PATHOLOGICAL APPLICATIONS OF SPECTRUM ANALYSIS. With Notes on Spectrography in Chemistry and Mineralogy, and Tables for Qualitative Analysis; being the Authorised Translation of Part II of *Die Chemische Emissionsspektralanalyse*, by Dr. Walther Gerlach and Dr. Werner Gerlach. Translated by Joyce Hilger Twyman. (145 pp. Royal 8vo., 52 Illustrations, bound in cloth boards. January 1935.) 14*s.* 6*d.* nett. 15*s.* post free.

Messrs. Adam Hilger, Ltd., in pursuance of their dual rôle as producers of spectrographic apparatus and disseminators of spectro-analytical information, have added to the series of text-books that they publish, a translation of Part II of *Die Chemische Emissionsspektralanalyse* by Walther and Werner Gerlach. The authors form a combination especially suitable to the work covered by the book, the one an eminent physicist who of late years has devoted intensive study to spectro-chemical analysis, the other a professor of pathological anatomy. Together they have applied to the difficult problems of pathology, the powerful means of attack provided by spectrography. Such diverse subjects are treated as the distribution of metals in the body with particular reference to therapeutic uses of heavy metals; the deposit of metals on flesh or clothing by electric discharge (as in electrocution) and the analysis of bullets, and the traces of metals left by bullets throughout the various portions of the path of a bullet wound. The application of spectroscopy of special chemical problems is also discussed. Not the least valuable section of the book consists of tables in which are given not only the most sensitive spectrum lines for the determination of various metals, but also lines of other metals with which they might be confused in the analysis of given substances, and guidance as to the avoidance of such difficulties. The technique of spectrochemical analysis has extended into many branches of technology in the last few years, and this account of its use in a comparatively fresh field promises great help in some difficult problems of pathology, and clinical and forensic medicine.

* * *

AN INTRODUCTION TO INORGANIC CHEMISTRY. By Satya Prakash, D.Sc., Lecturer in Chemistry, University of Allahabad. (Kala Press, Allahabad.) Pp. 478. Price Rs. 6.

This book is meant to cover the syllabus in 'Inorganic Chemistry' for the B.Sc. degree of Indian Universities and to be read in conjunction with a text-book for the Intermediate classes.

While one very much appreciates the references to the mineral resources and industries of this country, the elaborate and sometimes unimportant details of output of ores, cost, etc., seem to be superfluous in a text-book of this kind.

The summaries in the form of comparative statements at the end of every chapter, indicating the methods of preparation of different compounds are a special feature.

Manufacturing processes of a number of important compounds have not been dealt

with in any detail: the methods of manufacture of substances like Sodium carbonate, Sodium hydroxide, Ammonia, Sulphuric acid (contact process) have been disposed of in a few sentences.

While the modern trend both in teaching and writing of text-books aims at co-ordinating inorganic and theoretical chemistry, it is surprising to find the author deliberately excluding all physical chemistry. The physico-chemical principles involved in technical reactions, *e.g.*, the synthesis of Ammonia, the manufacture of Nitric acid from air, have not been explained. The ionic theory, the law of mass action, and Le Chatelier's principles as applied to inorganic reactions find no mention. One looks in vain for at least a passing reference to topics like corrosion, passivity, Werner's view on co-ordination compounds and theories of catalysis which have always found a place in standard books on Inorganic Chemistry.

The method of presentation of facts is not satisfactory. The printing and get-up of the volume leave much to be desired. Typographical errors abound. Very few diagrams are given and these are poorly drawn.

As one who has been teaching the B.Sc. classes for several years the reviewer feels that there is not much to commend in the book.

M. SESHAIYENGAR.

* * *

THE CHEMISTRY OF PETROLEUM DERIVATIVES. By Carleton Ellis. (The Chemical Catalogue Company, New York.) Price $ 18.

The author begins in the introduction by saying "World production of petroleum is approaching a quarter of a billion tons annually but, with new deposits constantly being found—indicative of the widespread distribution of oil throughout the land and under the sea—the apprehensions of a decade ago that the supply of this essential raw material would soon be exhausted no longer obtain." Again some exponents of petroleum technology have expressed the opinion that the large number of hydrocarbons present in the petroleum oil-wells in almost inexhaustible quantity should lead to industries to yield new substances which should compare favourably in their variety and utility to civilisation with the numerous useful products obtained from coal tar. The realisation of this dream has been hindered, as the author says, from a significant difference between the two groups of hydrocarbons, from coal t r and from crude petroleum, in that the chemical individuals of the former are comparatively easily separable from one another; whereas, the hydrocarbons present in petroleum oil are, in the main, indifferent to the usual conversion reagents, besides there is the possibility of an aliphatic hydrocarbon of one definite composition existing in an extraordinarily large number of isomeric forms rendering the task of individual separation immensely difficult. It can be cited as an illustration that a hydrocarbon containing 20 carbon atoms can exist in as many as 3395964 isomeric forms including stereo-isomers.

Although as the result of the impetus received from the researches of some veteran workers in this field, greatly improved refining procedures and efficient methods for the isolation of individuals have been discovered and progress towards 'quantity preparation' of pure compounds rendered rapid, it has not been possible yet to make the chemistry of petroleum as useful, scientifically and industrially, as could be desired commensurate with the vastness of deposit. Happily, however, past few years have witnessed the accumulation of a vast amount of research materials on this subject and an enormous growth in the number of investigators in this field.

This present volume covers 1,285 pages and the subject-matter has been grouped in 50 different well-arranged chapters including most up-to-date informations about petroleum technology and an elaborate treatment of the chemistry and utility of the derivatives of petroleum and a very useful author and subject index. Every effort has been made by the author to give references to most published material including the large amount of patent literature both of scientific and industrial interest. The book besides furnishing the reader with a fund of information bearing both on the industrial and the scientific aspect of the subject will, it is expected, greatly stimulate thought for further research, thus eminently fulfilling the high purpose of the author.

Carleton Ellis, one of the greatest authorities on this subject and in whose laboratory work of far-reaching importance on petroleum has been in progress for some years, took up the task of collecting and collating the widely diffused literature on this problem including the results obtained in his own laboratory, and by presenting this volume has rendered yeoman service to scientific

workers in general and those interested in petroleum research in particular.

P. C. GUHA.

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REPORT OF THE FUEL RESEARCH BOARD FOR THE YEAR ENDING 31ST MARCH 1934. (Published by H. M. Stationery Office, November 1934.) Pp. vii+178. Price 3*s*. net.

The above is a valuable document presenting a detailed account of the progress made by the Fuel Research Board in problems relating to the combustion of raw coal or its conversion into other forms of fuel.

The first section of the report relates to a survey of the coal resources of the country. The information obtained by the survey has been very valuable and has enabled colliery authorities to make modifications of working which increase the efficiency of the pits or improve the quality of coal as marketed.

The report then draws attention to the increased demand for small coal of which over 77 million tons are being annually cleaned by either washing or dry processes. Small coal has gained in popularity and is finding extensive use not only for domestic purposes but also in industries.

Carbonisation of coal is now being investigated on works scale at the Fuel Research Station. Researches on the extraction of motor spirit and fuel oils from coal are also in active progress. The lighter fractions of tar together with the spirit 'scrubbed' from gas produced by carbonisation provide an excellent motor spirit of which 40 million gallons are being produced annually in Great Britain. The motor spirit has already been tried by the Royal Air Force with very satisfactory results. Large quantities of the fuel oil have also been taken up by the Royal Navy. In addition to the above, the possibilities of obtaining mineral oil from tar is also being investigated, a process of hydrogenation at high pressure (upto 400 atmos.) and temperature (upto 250° C.) being tried. Some new problems have arisen in the direct hydrogenation of coal and a systematic study of the influence of inorganic constituents of coal on the rate of hydrogenation is in progress and is expected to yield useful results. Researches are also in progress to determine the efficiency of burning pulverised coal in boilers with small combustion spaces. Three new types of fuel burners have been devised. One of these, the 'Grid' burner is already being manufactured by one commercial firm. Another prominent line of enquiry is the manufacture of motor spirit from rubber. Under favourable conditions of temperature and pressure, rubber is readily amenable to hydrogenation and a yield of motor spirit corresponding to about 50 per cent. of the weight of the original rubber is obtained. Under other conditions a pale yellow viscous oil can also be obtained. If rubber can be obtained at a low price, it should be possible to manufacture motor spirit and lubricating oil out of it with comparative ease.

The above report is an interesting instance to show how organised co-operative research on a large scale can yield highly fruitful results. India has also a supply of coal as also an area under rubber which could be greatly increased if more use could be found for that product. In view of the importance of liquid fuel in the industrial advancement of the country, it is hoped that the above report will engage the attention of the Central Government and will eventually lead to the inauguration of an organised scheme of research that will yield useful results in the near future.

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LANOLIN RUST PREVENTERS. Second Edition. By C. Jakeman. Engineering Research Special Report No. 12. Pp. iv + 26. Department of Scientific and Industrial Research. (H. M. Stationery Office, London.) Price 6*d*. net.

The second edition of this interesting report is a valuable contribution to the problem of the rust prevention of steel plant and machinery during storage. The tests which extended over a period of five years have been carried out under a variety of exacting conditions, so that the encouraging results reported with the Lanolin compositions recommended, may be accepted with confidence. Benzene has been found to be the best solvent for lanolin and to deposit the best protective coating. Oil soluble dyes are recommended for incorporation with lanolin compositions so that one can easily spot the parts not coated.

In spite of the excellent results obtained with lanolin and its superiority over other classes of reputed rust preventers, it is admitted that it does not provide a "universal panacea" for corrosion. Occasional failures have occurred and no explanation can be offered in the present stage of investigation. It is significant that such failures have been recorded with coatings on hardened steel and it may be worthwhile to investigate the protective capacity of lanolin

compositions in relation to the composition of steel under test.

The report gives practical details of preparing lanolin compositions, preparation of surfaces for their application and describes methods of successful application to ensure uniformity of protective coating. This highly useful pamphlet will be gratefully welcomed by those interested in the protection of steel plant and machinery.

M. S.

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EVERYDAY BOTANY. By L. J. F. Brimble, B.Sc. (Lond. and Reading). (Macmillan & Co., Ltd.) Pp. 589. Price 7*s.* 6*d.*

The book is intended primarily for the use of pupils studying for the School Certificate and Matriculation examinations and also as an introduction to the subject for students, who wish to take up later on Medicine, Pharmacy, Forestry, Horticulture and Agriculture.

There are 23 chapters covering practically all the aspects of Botany, namely, morphology, histology, physiology, ecology, evolution, heredity and classification of plants. The book is written in easy and readable style and profusely and well illustrated. Practical exercises are given at the end of each chapter, which greatly add to the value of the book.

The author, in this book, has attempted to treat Botany by dealing with the applications of plants in daily life, while at the same time giving a general account of the subject to meet the requirements of the examinations. The structure and functions of the several parts of plants are dealt with and at every stage the practical applications of these in every-day life are referred to then and there. The treatment of the book is quite logical on the whole. But the author has taken up too wide a field by attempting to give information regarding the utilitarian side of all aspects of plant life with the result that he is forced to be very cursory (evidently owing to lack of space) in his treatment of practically every aspect of the subject, both academical and utilitarian. As a result only brief references to structures and functions of the several parts of plants are given without any attempt at a detailed explanation of them. The same defect is seen while the author was dealing with the several applications also of plant life. The pupils will, therefore, get only a very superficial idea of all these aspects. We are afraid that a pupil trying to obtain a knowledge of Botany with the aid of this book *alone* will not get a proper grounding in the subject. If he has a general elementary knowledge of the subject already from class teaching or from some other text-book, then he will find the book very useful for supplementary reading.

The book, however, will be found very useful to teachers, who will find in it plenty of suggestions regarding the applied side of Botany, which they could with profit incorporate in their class teaching.

## Forthcoming Events.

### ELECTRICAL ENGINEERING SOCIETY, BANGALORE.

*(The Meetings will be held at the Indian Institute of Science at 3 p.m.)*

March 6th. "Economical Design of Transformers." By Mr. M. V. Keshava Rao, B.Sc.

March 13th. "Recent Trends in Insulator Manufacture." By Mr. N. V. Raghunath, B.A., B.E., Assoc.Amer.I.E.E.

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CONTENTS.





## A Scheme of Broadcast Development for India.

ELSEWHERE in this issue of *Current Science* appears an article on the development of nation-wide radio broadcasting in India to serve as a most valuable tool for national reconstruction on the only possible basis of the renaissance and reconstruction of the village and village life. An examination of the development and present status of broadcasting in such typical countries as France, Germany, Great Britain and Russia in Europe, Canada and the United States in Northern America, and China and India in Asia, leads to the irresistible conclusion that the fundamental cause of the deplorable absence of any progress in India is the apathy and the lack of appreciation by the public and the governments in India of the value and potentialities of broadcasting as a matchless universal propagandist instrument for the promotion of the welfare and happiness of the community and for safeguarding its interests.

The reasons usually put forward for the present pitiably backward condition are unconvincing and really not correct. It is said that the contributory factors are the size of India and its huge population, the pronounced racial, linguistic and religious divisions, the enormous disparity in cultural development between the various sections of the people and chronic poverty and mass illiteracy. But these are not peculiar to India alone; each and every one of them has been and continues to be a striking characteristic of Russia and Russian life. Yet these undoubtedly serious difficulties and disadvantages did not prevent the builders of modern Russia not only from putting Russia on the radio map of the world, but achieving for it a position in the front rank in the radio world in the short space of some half a dozen years. Nor is it correct to say that the severe political unrest and the economic troubles of recent years have stood in the way of Indian radio development. Many other countries, notably, Austria, Germany, Italy and Russia have passed through or are still in the midst of acute political and social turmoil and severe economic distress. Yet they are noted for extensive broadcast development. Even Mexico and China are ahead of India in this respect. Further, it is not clear if

the conduct of the broadcast service from the Bombay and Calcutta stations and their programme composition are based on any well-defined policy with a clear understanding of the main objectives. There is none so poor in the world as India in the matter of broadcasting.

But the budget allotment of 20 lakhs of rupees for broadcasting by the Government of India, their decision to put up a 25 kw transmitter at Delhi and the highly commendable procedure of the Government of Madras in putting forward a worthwhile scheme for the whole presidency after detailed examination of the question by a competent radio engineer, appear to indicate that India has started on the road towards having a satisfactory system. The question arises if behind these there is a well-considered comprehensive plan of development for the whole country in regard to (*a*) organisation, finance and programme policy; (*b*) number and powers of stations and their location; (*c*) the interconnecting wire network; (*d*) receiver distribution; (*e*) manufacture in India of the necessary apparatus; (*f*) development and research in regard to all matters of technique, materials, apparatus and operation; (*g*) the training and recruitment of the necessary personnel of all grades; (*h*) relations with the press, the state departments and foreign broadcast administrations; (*i*) the important question of television and allied matters. A *laissez-faire* policy will be thoroughly wasteful in men, money and effort, besides causing confusion and inequitable and non-uniform development in the country. Any worthwhile development plan has to be based on a thorough examination and critical study of the world situation in broadcasting in all its aspects. And that can be done only by sending out a competent and fully authorised commission of inquiry as advocated at the end of the article. Will the Government act on the suggestion?

Even a brief consideration of the question of broadcasting *on a nation-wide basis* shows that low powers and short wavelengths for transmitters are out of question. There is really no satisfactory alternative to high power and medium wave policy, if the whole area of the country should be brought under adequate and reliable broadcast coverage as determined by daylight reception on an average type of receiver so as to be free from atmospheric disturbances at all parts of the year. Short wavelengths are suitable for long distance reception during limited parts of the day and have entertainment value only with well-designed and rather expensive receiving apparatus.

The transmitting system as visualised in the article is an essentially conservative estimate of requirements. It will probably be found that the number of stations in each category may have to be doubled: the individual powers, particularly of the regional transmitters, may have to be increased by 50 per cent. A receiver per cent. of the population is an under-estimat but is a satisfactory objective to start wit

Community ownership of receivers an community listening were first started Russia; in countries of high developme such as Great Britain, Germany and t United States, this practice is a feature schools and clubs of all sorts. There is suitable alternative to this in India, least for the present.

In regard to the organisations of broadcasting, the article is most emphatic on four basic requirements: (*a*) to retain the unreserved and whole-hearted trust and confidence of the people, the organisation should be completely above the slightest trace suspicion of allegiance to party and section interests of any type; (*b*) the organisati should be an unqualified national monopoly financed exclusively by the licence fee an public funds and existing solely for t education, enlightenment and entertainme of the community; private commer should be rigidly excluded from any voi or control on policy or day-to-day condu of broadcasting; (*c*) the organisation shou be such as to ensure uniform broadca facilities throughout the land and the main tenance of the highest standards of excellen in apparatus, methods and operation; an (*d*) each region should have and exercise t utmost possible freedom in all programm matters.

Organisation as a government departme or as private commercial enterprise is bot impracticable and intolerable. A highly centralised system such as the British Broadcasting Corporation which has made Great Britain so pre-eminent in broadcasting is wholly unworkable. A non-profit making autonomous public utility organisation with complete centralisation of all technical services and as complete decentralisation in all programme matters and of the type advocated in the article is the only solution.

It goes without saying that advertisement by radio should not even be thought of.

Everywhere and at all stages, the success or failure of a broadcasting system depends on the underlying programme policy and daily programme composition. The only criterion is entertainment and educative value as determined by variety, balance, utility and wide appeal to every section of the community in regard to age, sex, occupation and linguistic and racial grouping. Monotony, stiffness and heavy seriousness kill broadcasting outright. It is futile and shortsighted to design and put up receivers tuned to the local station. That is the finest way to create suspicion and repel the listener. Foreign station listening should be encouraged; it is of some educative value occasionally to hear completely unintelligible music and talk and the sounds of strange voices and instruments far away. And in any case, it is far sounder to make the daily programme so rich, varied, interesting and instructive and of such high entertainment value, that the rural listener, of his own accord, prefers it to others.

Of vital importance to broadcasting and the radio industry in India are the questions of the manufacture of radio apparatus, research and the training of engineers. It is impossible and intolerable to be dependent for them on countries abroad. Distance, cost, natural differences in the conditions of working are all against it. In these matters, private commerce in India and the various educational institutions have a large and fruitful part to play on the basis of a carefully considered definitive formulation of a progressive and far-seeing broadcast development policy.

While the article rightly insists that the broadcasting system has to be built up it has not ventured upon any discussion on the first step to be taken. Such a discussion would have probably been useful though rather premature. But whatever its merits or demerits, it is based upon a careful study of the history and present status of broadcasting abroad and prolonged and earnest consideration of the possibilities and requirements in regard to India and Indian conditions. The article will have more than amply served its purpose if it helps "to create a correct perspective of the vast problem and provoke reasoned discussion on what is inherently a national question" and "to offer some concrete basis for such discussion".

R. E.

## The Royal Institute of Science.

WE have received a copy of the second report of the Royal Institute of Science, Bombay, for the period 1926–1934, and we have great pleasure in congratulating the Principal and Professors of this Institution on their unremitting exertions in implementing its declared policy and in achieving great progress in the creation of an atmosphere of research in practically all the departments of science.

The Institute which was founded with the aid of public donations amounting to Rs. 30 lakhs, commenced teaching work in 1920 and was affiliated to the Bombay University for the B.Sc. degree courses in Mathematics, Physics, Chemistry, Botany and Zoology in 1926. In 1933 the then Governor of Bombay handed over the east wing of the Institute to the University to house the new University Department of Chemical Technology. All the scientific departments are well staffed and are fully equipped for the routine teaching work as well as advanced research work. The Library, which is one of the best in the Presidency, contains six thousand volumes of periodicals and five thousand books, but the annual additions to the lending and reference sections of the library, which at the present moment amount to one hundred books and about eighty scientific journals, must naturally depend upon the grants available for the purpose. It seems to us that in view of the important position which the Institute occupies in the academic life of the Presidency and the high purpose which it is so worthily fulfilling, the great industrial magnates of Bombay will increasingly recognise the imperative need of placing the College above financial want; and once they are convinced that research, and not necessity, is the parent of invention as well as of industrial prosperity, their own enlightened self-interest will lead them to create ample endowment fund so as to ensure an adequate annual income to the Institute for post-graduate scholarships and expenditure on research departments.

A great industrial centre like Bombay

should legitimately be interested in the promotion of chemical research and it is gratifying to note that during the period under review, out of a total of 128 original papers published from the Institute, 64 belong to the Department of Chemistry and out of a total of 96 approved theses submitted by research scholars, 52 have been produced by Chemistry students, and similarly there are 52 theses of research in progress in the chemical section of the Institute. The output of investigations from other departments is equally impressive.

The departments of Physical Science in the Institute are the most favoured by the students: there were 71 post-graduate students out of a total of 91 in these sections during 1933–34 and 51 out of a total of 61 students in the same departments in the Senior B.Sc. class in the same period. In 1932–33 the annual cost of educating each student in the Royal Institute of Science was Rs. 608 to which Government contributed Rs. 181. In a country like India where the general public is slow to recognise the advantages of promoting scientific researches, the obligation of Provincial Governments to provide sufficient funds for this purpose becomes greater, especially in view of the fact that almost all the scientific results when used in the technological and industrial concerns, are capable of being taxed. Governments and industrialists stand to gain immediately from scientific work and it should, therefore, receive the greatest encouragement at their hands.

It may be pointed out that the staff cadre of the Institute is capable of improvement. The gap separating the Professor drawing Rs. 1,200 and the immediate next member, an assistant lecturer on Rs. 225 is unnatural and almost unbridgeable. There must be an assistant professor or associate professor in each department on appropriate salary, who could be entrusted with the responsibility of taking charge of the department during the absence of the professor.

The report suffers from one slight defect. On page 23, we read that "sanction has been obtained for an Institute Badge, tablets for academic and athletic rolls of honours have been erected and an Institute Magazine has been started". We should have wished for a fuller information on the social, athletic and other extra-mural activities of the Institute students than is provided by this brief reference.

The report is an interesting document and constitutes a notable record of progress in every department in the Institute whose increasing prosperity and scientific achievements should be an honour to the Principal and Professors and pride to the benevolent public and Government of Bombay.

## Nationwide Broadcast Development in India.

By K. Sreenivasan, B.Sc., A.I.I.Sc., A.M.I.E.E., Mem.I.R.E.

Any worthwhile broadcasting system seeking to serve the mass of the people is inherently a nationwide and national problem. It cannot be considered in the circumscribed sense of a local or even a provincial question. If there is any single problem in which a genuine national outlook is imperative and which demands well-considered nationwide planning, it is radio broadcasting. In technical services, in administration and finance and in programme policy and programme development, every consideration of national economy and social welfare insists upon the whole question being treated as a national problem with the three-fold objective of the instilling of the idea of common Indian citizenship and the promotion of social solidarity, the promotion of public health and of economic prosperity and the spread of general culture and healthy entertainment.

These have to be the aims with reference to the mass of the people living in villages. No organisation and no expense can be anything but waste of wealth and effort when they do not directly and consciously strive after the amelioration of the conditions of life of the rural population which forms the spiritual and economic backbone of the country. A nationwide broadcasting system is justified only when it has for its starting point the villager as citizen, producer and consumer; its fundamental purpose is as the most effective and finest tool in national reconstruction in terms of the rural population living in 650 000 villages.

With these objectives, the organisation of broadcasting has to be on the basis of a

national monopoly deriving its moral support and material strength direct from the listener and always consciously striving to serve his best interests. Conceived thus as an instrument of public service of the highest character, private commerce and vested interests of any kind cannot have the slightest voice in the policy and daily conduct of the service in any shape or form.

BROADCASTING ABROAD.

Before attempting to visualise the magnitude of the broadcasting problem in India, it is essential to survey briefly the status of broadcasting abroad.

In Europe, the organisation of broadcasting is mostly in the form of a national monopoly in the sole interests of the community and of the nation as a political unit. Great Britain offers the best example of a highly centralised type, appropriate to its small size and its homogeneous population. Till the advent of Chancellor Hitler, Germany had a federalised monopolist organisation consistent with its bigger area and its more varied population. In these countries, the periodical subscription from the receiver owner is the most important source of revenue. In Russia, the organisation is under the dictatorial control of the people's central commissariat at Moscow; the State looks after the financing of broadcasting and its development from year to year. In the United States of America, on the other hand, broadcasting is in the hands of private enterprise which raises the necessary revenue by radio publicity of goods and services of private competitive commerce. The Federal Communications Commission, a government body, endeavours to secure equitable development of broadcasting throughout the country and ensure reception free from interference. In India, broadcasting started in 1927 as a private commercial monopoly with the licence fee and radio publicity as the two sources of revenue. When, however, this arrangement collapsed, the State took it over and is now responsible for the conduct of the service from the Bombay and Calcutta stations.

From Table I some idea of the popularity of the service in the different countries can be obtained from an examination of the available broadcast facilities and of the number of receiving sets in each. In Germany, there are 26 medium wave transmitters with a total antenna power of over 800 kw. There are over 6 million receivers for a population of 63 millions. Great Britain, which is about half the size of Germany or about one-twentieth of that of India in area, has 14 transmitting stations with a total antenna power of over 550 kw. The number of receivers for a population of 44 millions stands at the very high figure of over 6·7 millions. In the United States, the absence of any national organisation and an initial well-considered development plan has burdened the country with about 600 transmitters. There are over 18 million receiving sets in the country corresponding to 13·1 receivers per cent. of the population. Recently the country provided itself with a 500 kw. transmitter at Cincinnati.

Russia hardly existed on the map of Europe seven years ago. The difficulties in the path of radio development at that time were at least as great as those of India at present. The country is four times as large as India; the population of about 15 crores consists of some 200 racial groupings speaking over 50 different languages and with a range of cultural development from the most primitive to the most advanced. Political and economic revolution of a most drastic character had left the country completely isolated from the rest of the world and the internal upheaval had not yet shown signs of subsidence. But under the dynamic urge of the gigantic plan of organised and comprehensive national reconstruction, radio broadcasting as the most potent tool of nationwide economic and cultural propaganda developed by leaps and bounds. At present, this vast and varied country has 75 transmitters with a total antenna power of 1 500 kw; one of these is the biggest in Europe with 500 kw in the antenna. For a population of 147 millions, there are at present 3 million receivers. Plans for the extension of broadcast facilities during the next few years include the construction of a 1 000 kw transmitter and the increase in the number of receivers from 3 millions to 20 millions corresponding to 14 receivers for every hundred of the population.

For the world as a whole, it is estimated that there are some 2000 transmitters with a total antenna power of roughly 10 000 kw, spread over the inhabited area of 143·7 million square kilometres, and about 45 million receivers for a population of some 1 800 millions. This gives a world average of 2·25 receivers per cent. of the population.

With a most varied population of 351 millions inhabiting 4·66 million square

kilometres, India has a transmitter at Bombay, one at Calcutta, a small one at Madras and a small short wave transmitter at Calcutta, all employing obsolete apparatus. The total antenna power does not exceed 7 or 8 kw. The number of registered listeners does not exceed 12 000, corresponding to a receiver for every 29 000 persons in the country. The service is burdened with a small army of radio pirates who enjoy illicit listening (Fig. 1).

The programme service lasts for 18 hours a day in the United States, 18 hours in Germany, 13·25 hours in Great Britain and about 11 hours in Russia; Bombay transmits for about six hours a day and Calcutta an hour longer. Madras transmissions last about two hours in the evening.

On the financial side, the investment on transmitting equipment in Europe in 1931 was estimated at about 22·5 crores of rupees while that on receiving apparatus was ten times as great. The annual receiver maintenance charges for the same year were estimated to be about 30·2 crores of rupees while the licence fee realised from the listeners amounted to no less than 18·9 crores of rupees. Electricity consumption for broadcast purposes four years ago stood at about 1 573 million kilowatt-hours.

In the matter of programme service, every broadcast organisation in the progressive countries of Europe and America strenuously endeavours to cater to all worthwhile and ascertainable needs and requirements of every section of the community in respect of age, sex, cultural level, occupation and economic and social stratification. The permeation of the effects of broadcasting are so real, deep and universal that it has become a powerful living social force affecting and reflecting the daily life and thoughts of the community. Broadcasting is at once the mouthpiece of the community and its most powerful and universal educative organisation.

Considered from any standpoint of national interest and social well-being, the service in India is hopelessly poor and inadequate. It may be doubted if it has had well-considered and well-defined objectives and policy. In these days of intense and world-wide moral and intellectual upheaval, involving profound changes in the scale of values of ideas and institutions, broadcasting in India has not till now made the slightest contribution as a propagandist and educational instrument.

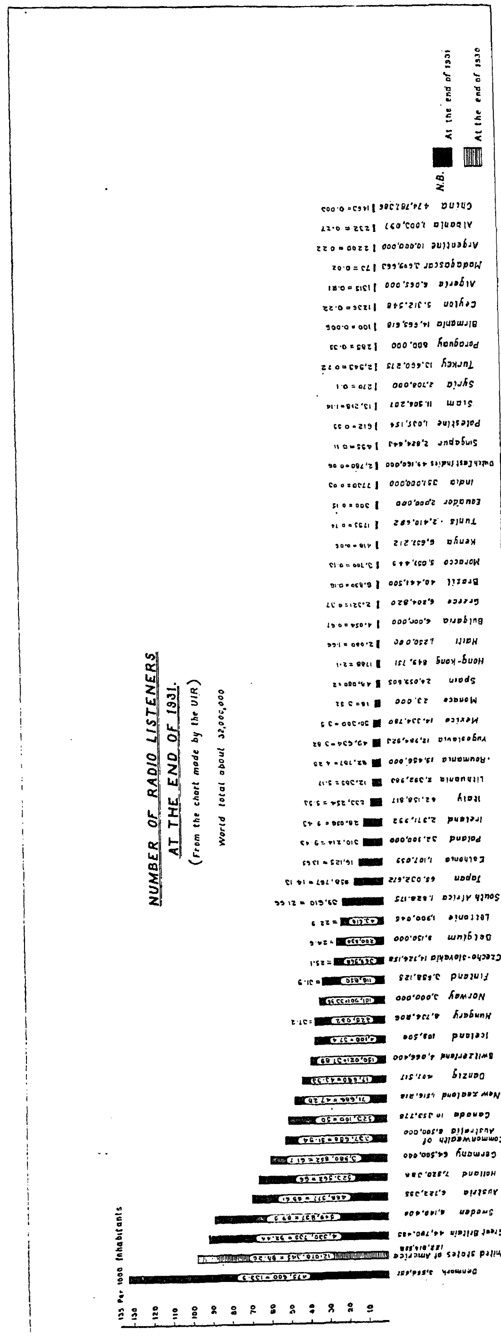



**Fig. 1.**

The period of apathy and standstill in matters of broadcast development in India appears to be coming to an end. A year ago, the Government of Madras took the lead in starting a preliminary examination of the question of broadcasting for the

presidency; indications go to show that the scheme submitted by them to the Central Government is of a character as will assure the presidency, if put into execution, of a thoroughly satisfactory and up-to-date system. Of greater significance is that the Government of India is also active as shown by their decision to put up a 20 kw transmitter at Delhi and the budget allotment of 20 lakhs of rupees. It is not clear, however, if this forms the first step of a well-planned, comprehensive nationwide broadcast development policy.

PROBLEM OF NATIONWIDE BROADCASTING.

With some idea of the status of broadcasting abroad, we can now consider the problem of what constitutes nationwide broadcasting. On the theoretical side, we have to consider (*a*) the number and individual powers of transmitters and their location to secure for the listener throughout the day and all the year round a satisfactory and adequate signal in relation to atmospheric disturbances; (*b*) the necessary high grade telephone network to interlink the different stations for distribution and interchange of programmes; and (*c*) the number of receiving sets to ensure that any one desiring to listen to the radio programme of entertainment and instruction can do so. The organisation should be such as to assure uniformly efficient and economic technical services throughout the land and at the same time guarantee the utmost flexibility and freedom to every region in programme-building within the broad confines of a well-considered and well-understood national policy.

There is the proposal for the installation of small power stations with service areas of 25 or 50 kilometres radius, so that each locality or district can have its own programme and in its own language. In support of this proposal, a representative of a radio firm of Great Britain has been touring the country visiting various governmental authorities. Within the last few weeks, schemes on this basis have been inaugurated in the North-Western Frontier Province and the United Provinces. Satisfactory as it may be in the case of isolated small areas, the proposal is thoroughly unsound, impracticable and unworkable on a nationwide basis. It will involve hundreds of stations, all to be accommodated within a strictly limited band of frequencies. Even with unusual and expensive precautions, regions of interference will be inevitable; it is certain that except in the neighbourhood of transmitters, atmospheric disturbances will ruin reception. Difficulties connected with the availability of suitable microphone talent in each locality and of programme expenditure for such a large number of transmitters cannot be exaggerated. Recorded entertainment and voluntary microphone talent can never be sustained in quality and adequate in volume to prevent boredom, monotony and heaviness.

More important than any of these is that such a scheme is a standing invitation for the perpetuation and aggravation of the baneful spirit of provincialism and of the numerous sectional interests which tend to disrupt the community into mutually antagonistic fragments. Everything should be designed with the deliberate aim of promoting social harmony and solidarity in common citizenship.

On the other hand, there are those who suggest the erection of a small number, say a dozen, of super power stations located suitably. It will be urged that besides being very economical and efficient in money and effort, such a scheme will assist powerfully the promotion of social harmony.

While there are no difficulties in putting up very high power stations, such a scheme will involve large wipe-out areas round the transmitters, rapid reduction in intensity with distance, etc. Further, it will be impossible to serve the worthwhile and legitimate needs and requirements of the varied population and to preserve and enrich the varied culture of the country.

From every point of view, the most satisfactory arrangement appears to be to develop broadcasting on the basis of the main linguistic divisions of the country. This will give the fullest possible scope for cementing the people together and at the same time assure the preservation and growth of the culture and traditions characteristic of each region.

Taking the ratio of the total antenna power in the different countries to the corresponding area of each, one watt per square kilometre for India appears to be reasonable and satisfactory to start with, in view of the nature of the country and the prevalence of atmospheric disturbances. This gives 4 660 kw of antenna power for the whole of India. The corresponding figures for Denmark, Germany and Great Britain are 1·65, 1·73 and 2·28 watts per square kilometre; and every year sees an increase in them.

Bearing in mind that the most important criterion in the location of each station is the availability of suitable microphone talent in each linguistic area, between 60 and 65 regional stations will probably be adequate to serve all legitimate interests and requirements. On this basis, Hindi and allied languages in the north will have 16 stations; Bengali will have 6, Telugu 5 and so on.

In addition to the 65 stations catering to the regional requirements, five national transmitters located, say, at Lahore, Patna, Nagpur, Bangalore and Rangoon, will put on the air programme matter of national interest. Broad questions relating to international trade, foreign affairs, national defence and economy will come within the purview of these transmitters.

For purposes of long distance international broadcasting, five short-wave transmitters located, for example, at Delhi, Calcutta, Bombay, Karachi and Rangoon, will complete the picture. The country will thus have between 70 and 75 stations.

In the matter of power allocation, each of the five national transmitters will have 250 kw in the antenna and each short-wave transmitter 50 kw. The regional transmitters can be divided into two categories; 45 transmitters each with an antenna power of 25 kw and 20 transmitters each with 75 kw. To take care of inadequately covered areas there will have to be a number of relay stations, the power of none of which will exceed 0·5 to 1·0 kw (Fig. 2).

TELEPHONE LINES.

An adequate system of interconnecting high grade telephone line network for distribution and interchange of programmes and

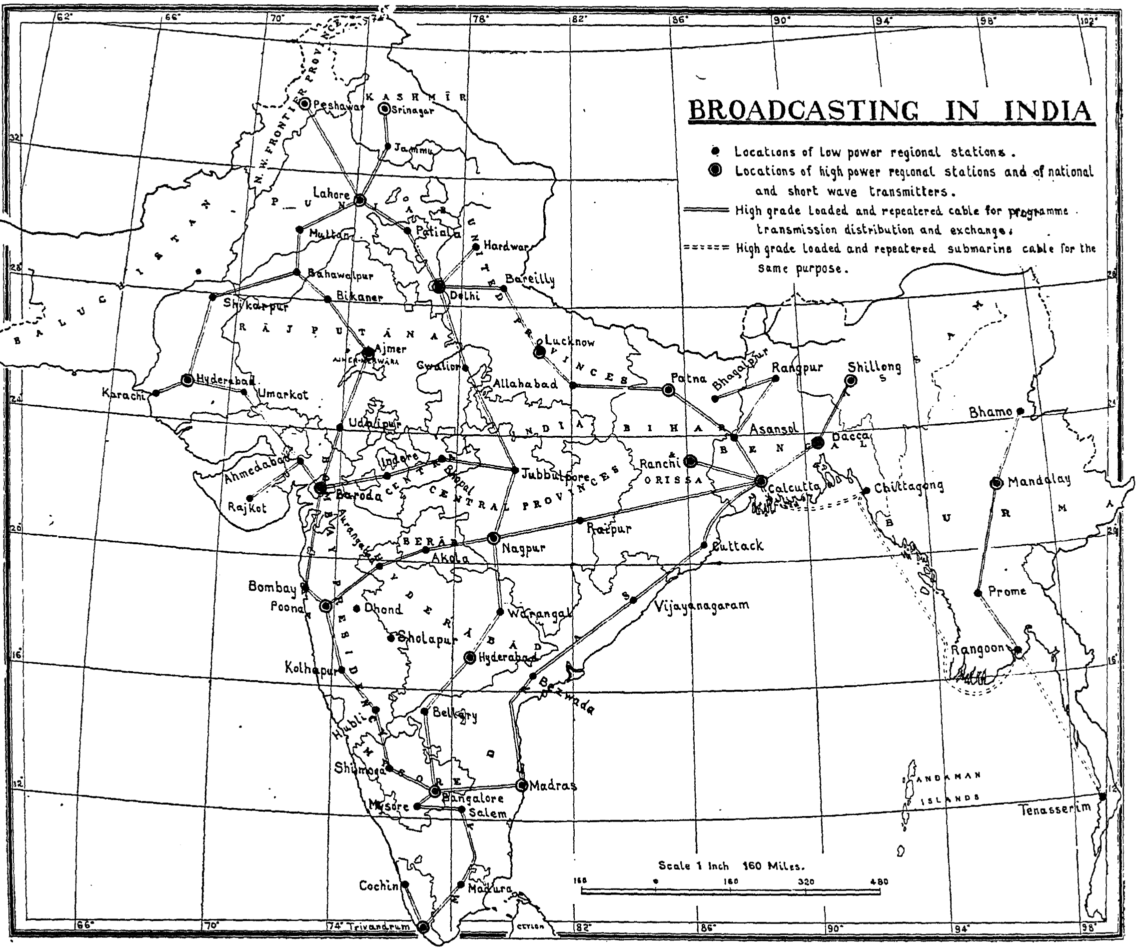



**Fig. 2.**

for national hook-up whenever necessary is indispensable. Europe and America possess extensive networks of this character. They are absolutely essential in our tropical climate with its generous supply of atmospheric disturbances for at least eight months in the year.

The telephone network suggested here can be divided into (*a*) the Indus system from Lahore to Karachi (1 300 km); (*b*) the Western India system from Lahore to Bangalore through Baroda and Bombay (2 800 km); (*c*) the Mid-India system from Lahore to Travancore through Agra and Nagpur (3 000 km); (*d*) the Gangetic system from Lahore to Calcutta through Delhi and Allahabad (2 000 km); (*e*) the East Coast system from Calcutta to Madras (1 800 km); (*f*) the Bombay-Calcutta system (1 700 km) and (*g*) the Central Burma system (2 000 km). The figures inside the brackets are approximate route distances and total 14 600 km. With two pairs of wires for programme transmission and a similar number for control purposes, the total length of wire pairs in the network will be of the order of 60 000 km. For such a small country as Great Britain, the total wire system used for broadcasting is in excess of 6 000 km.

The above represents in broad outline the picture ot the transmitting system.

### RECEIVER DISTRIBUTION.

In regard to the distribution of receivers private family ownership is out of question, at least for the present, with a *per capita* income of about Rs. 100. There is no suitable or satisfactory alternative to community ownership of receivers and community listening. The provision of a receiver per cent. of the population giving a total of 3·5 millions for the whole country is a very satisfactory immediate objective. This number for this huge country is very modest. Even now, for every hundred of the population, Denmark has 16 receivers, Great Britain 15·24 and Germany 9·75.

### CAPITAL OUTLAY.

The essentially conservative broadcast development plan as visualised above will involve an immense amount of money and effort. No pretence to any great accuracy is possible and the estimated figures of cost given here do not claim to be any more than very roughly representative.

Transmitting equipment investment includes the costs of the transmitter, the antenna, land and buildings, studio and office equipment, etc. The total figure naturally increases with the antenna power of the station.

| Category of transmitter | Antenna power in kilowatts | No. of stations | Cost in crores of rupees |
|---|---|---|---|
| Medium power regional | 25 | 45 | 2·7 |
| High power regional | 75 | 20 | 3·0 |
| National .. | 250 | 5 | 1·5 |
| Short wave .. | 50 | 5 | 0·3 |
| TOTAL .. | | | 7·5 |

The cost of a receiver is dependent on a variety of conditions; a simple crystal set with a pair of phones need not cost more than Rs. 15 or 20 exclusive of antenna and earth arrangements; at the other end there is the all-mains, all-wave multi-tube modern receiver housed in an excellent looking cabinet which might cost anywhere between a few hundred to a couple of thousand rupees to the ordinary buyer. A community-owned receiver has to be a robust and weather, insect, mischief and fool-proof apparatus, simple to operate and capable of accommodating an audience of, say, 200 persons sitting under a tree or in the village meeting place. The average cost of such a receiver, inclusive of loudspeaker, antenna and power supply is not likely to be under Rs. 300 even with efficient mass production conditions and direct distribution with the barest minimum of intermediary agencies. On this basis, investment on receivers will be to the tune of 105 crores of rupees. The total capital outlay on receiving and transmitting equipment, *exclusive of the telephone network*, will be about 113 crores of rupees.

### ANNUAL CHARGES.

In the first place, we have the maintenance and operation charges inclusive of obsolescence, depreciation, salary and power bill, etc. An American estimate of 1930 gave for the average for the world the figure of Rs. 45 per year per installed watt of antenna power. On the assumption of Rs. 20 under Indian conditions the running expenditure for 4 000 kw will be 8 crores of rupees a year.

Receiver maintenance charges per year vary with the type and size of the apparatus and on the average amount roughly to about 25 to 30 per cent. of the initial cost. There is not much to go wrong with the

modern all-mains multi-tube receiver nor at the other extreme the simple crystal set. It is the battery-operated set that is the most expensive and troublesome to maintain, particularly in India. On the basis of Rs. 75 per receiver per year, the annual bill will amount to a little over a minimum of 26 crores.

But in any progressive broadcast service worth the name, payments to artists and other direct expenditure on programmes should form the major part of the annual budget. Voluntary microphone talent, be it never so patriotic or willing, can never be adequate in volume, sustained in quality and varied in composition to be relied upon for any but the briefest part of the daily programme time. By its very nature, programme expenditure is difficult to estimate, varying as it does with the nature and duration of the programme, local conditions and above all, the artist. A minimum figure of Rs. 100 per hour per station will perhaps help to obtain a rough idea of the expenditure on programmes. Assuming an operation time of 4 000 hours per station per year, programme expenditure will amount to about 3 crores of rupees. Any worthwhile programme service will cost much more; it will certainly not be less. Thus the total annual broadcasting bill for the whole nation will be in excess of 37 crores of rupees, *excluding the annual maintenance and operation charges on the telephone network*. This figure should be compared with the annual military expenditure of 45 crores and a total expenditure on education of somewhat under 25 crores.

A nationwide broadcasting service has to be built up; it cannot be brought into existence by wishing for it. Up to date, accurate and comprehensive knowledge and understanding of the status of broadcasting abroad is essential; equally important is it to evolve a well chalked out development programme after careful consideration of all circumstances in order to ensure success from the beginning.

### ORGANISATION.

A word may not be out of place in regard to the nature of the organisation. If broadcasting is to be nationwide in scope and national in character as in other countries, there appears to be no alternative to its organisation as a non-political, non-sectarian, national authority of the autonomous public utility type completely free from the slightest suspicion of any trace of control or influence in any shape or form of private commerce. Secondly, in the matter of programme composition and expenditure, the organisation should ensure the daily exercise of the utmost possible freedom in each region in order to be responsive to all worthwhile and ascertainable requirements and tastes of the different regions of the country.

But the engineering and scientific services, equipment and personnel, in regard to every aspect of maintenance, operation, research, development and expansion should at all times be under the undisputed and undivided control of a central all-India body, to secure from the very outset the inauguration and execution of a well-considered and ordered development programme and to assure the maintenance of the highest standards of excellence and efficiency uniformly throughout the land.

There will therefore have to be a Central Broadcasting Council (Fig. 3) whose main functions will be the following: (*a*) undivided control of all engineering services, development and research throughout the land; (*b*) laying down broad lines of programme policy in consultation with regional broadcast administrations and national advisory councils; (*c*) collection of license revenue through the network of post offices and their distribution; and (*d*) regulation of relations with foreign broadcast administrations and the departments of state. And in all matters of policy and general administration, the Central Broadcasting Council will be responsible through the Minister of Communications to the central, that is, the all-India legislature.

The regional or Provincial Broadcasting Commission (Fig. 4) should be left completely free to devote all its energies to regional programme construction and its financing, in order to provide for the listeners within its region the best possible and varied daily programme of entertainment and instruction. The Provincial Commission will be assisted by a number of consultative committees to advise on policy, and *ad hoc* programme committees to assist in the composition of the daily programme. And in regard to programme policy, programme and allied expenditure and other similar questions within its purview, the Provincial Commission will be responsible through the provincial minister-in-charge to the local legislature. The main regional vernaculars will be the principal languages of broadcasting. Hindi as the principal language of India and English for

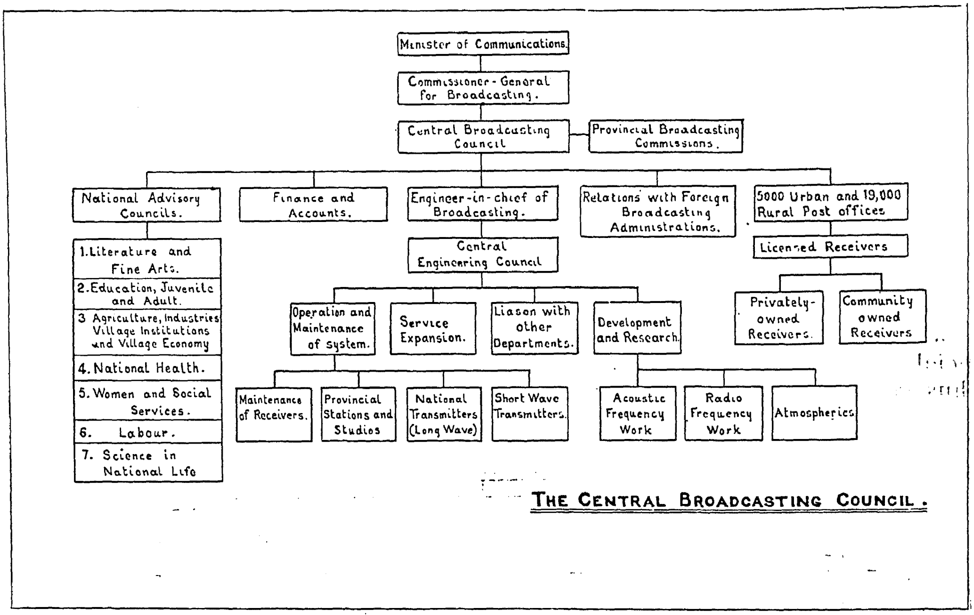



**Fig. 3.**

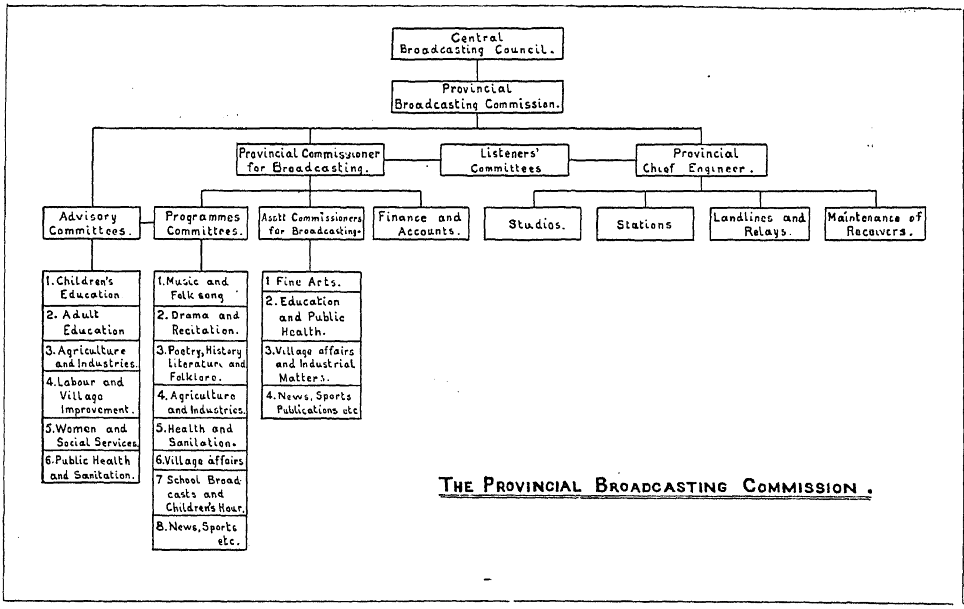



**Fig. 4.**

international communication will be the other two languages for each station. Only in this way can broadcasting in India earn and retain the trust, confidence and affection of the population and develop increasingly as probably the most beneficent and universal tool for the service of the community.

THE FINANCING OF BROADCASTING.

If broadcasting should be truly national in character and if it should be a matter of personal concern to every individual citizen, it is of the most vital importance that it should be financed entirely by the annual licence fee of the listener and by

direct state subsidy. That will be the most direct and tangible form of the listener's material and moral support and approval of the broadcasting activities throughout the country.

The Central Broadcasting Council will collect the licence fee in convenient instalments through the network of post offices; the postal department will retain about 2 per cent. of the collections for the expenses of collection. Of the rest, the Central Broadcasting Council will take 10 to 20 per cent. for its own expenses and hand over the remainder to the corresponding Provincial Broadcasting Commission which will thus get an amount of money proportional to the number of listeners it has built up in its area.

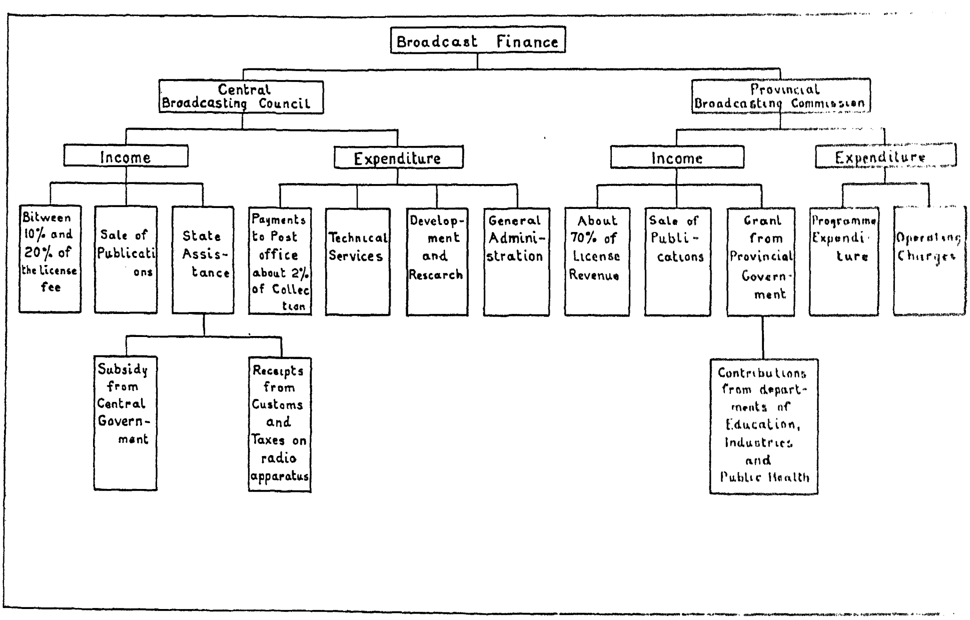



**Fig. 5.**

A second source of income for the central council will be from customs duties on imported radio goods to be handed over to it by the central government. And there is finally the annual subsidy by the government. In these three main ways, the Central Broadcasting Council will derive its revenues to meet its expenditure on general administration and on technical services of all-India character including development and research.

In addition to the proportion of the licence fee collected in its area, the Provincial Broadcasting Commission will obtain an annual subsidy from the local government, the magnitude of which will form a direct measure of the appreciation and approval of its programme service. There will also be some amount derived by the sale of publications. On the side of expenditure, there are (a) direct programme expenses, such as payments to artists, etc.; (b) payment to the Central Broadcasting Council for the maintenance and operation of transmitting and allied equipment on an agreed rate per hour of operating time; and (c) general administration charges.

This method of financing will act as a powerful incentive for each regional administration to improve constantly its programme service to the community. Programme expenditure will account for the major part of the provincial commission's income from all sources.

PROGRAMME POLICY AND COMPOSITION.

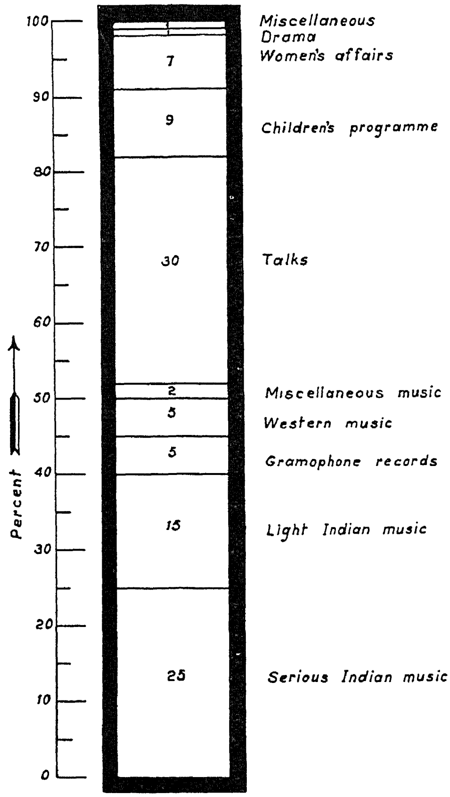
It cannot be too strongly emphasised that the success and popularity of any broadcasting scheme depends upon the programme policy and the character and daily composition of programme. If technical efficiency in apparatus and operation formed the chief criterion for judgment, broadcasting would be an unqualified success wherever money and competent engineering talent are available. If for any reason whatever, the daily programme features cannot attract and

steadily retain the interest and appreciation of the mass of the listeners, the service is best shut down in time ; for the continuation of a poor service will only earn apathy and disgust and prove a set-back to broadcast development under propitious circumstances.

Organised as a public utility and financed partly by public funds, there will inevitably be a tendency on the part of the service to emphasise and subserve unduly the ideas and views of official authority. If broadcasting should develop into a vital living force for good in the daily life of the community, official pressure and interference should be conspicuous by its non-existence except in declared cases of national emergency or of open violation of national policy to the detriment of the welfare of the community. Within the broad confines of a well-thought-out and well-defined general programme policy for the whole country, each provincial organisation should explicitly enjoy and exercise the utmost freedom in making up its programme with a single eye to social well-being and the interest, convenience and necessity of the listening public. On all matters relating to the political, civic and economic duties and privileges of the citizen, public health and sanitation, educational and industrial development, well-planned and insistent propaganda by the ether should form one of the cardinal features of programme policy and composition.

Current topics and subjects of controversy are inherently interesting to the listener. Balanced presentation before the microphone by competent persons of current topics and controversial subjects of every type helps to provoke broader and more reasoned and less lop-sided thought and discussion ; and that is an unmixed blessing all round. In the category of subjects of controversy for treatment before the microphone should be included arts, sciences, politics, social economy, war and peace, international affairs and indeed every subject on which division of opinion can exist, with the sole exception of religion ; in human affairs from the dawn of intelligence, there is no subject which has caused more unreason, unnatural division and strife and threatened to destroy the very springs of elementary commonsense, good-will and neighbourliness. Religion is best ignored in broadcasting.

Fig. 6 shows a suggested division of programme time and is based on an examination of practice in a number of countries.




DISTRIBUTION OF PROGRAMME TIME

**Fig. 6.**

Space does not permit even the briefest mention of a whole category of important questions relating to broadcasting, such as technical and engineering aspects of nation-wide broadcasting, frequency allocation, television, relations of broadcasting with education, industry and trade, the press, the theatre, the arts and so on.

MANUFACTURE AND RESEARCH.

It is clearly impracticable to import all the necessary transmitting, receiving, wire and a whole category of allied apparatus. To do so would be extravagant and wasteful in every way, in money, experience in technical, manufacturing and other matters, outlet for educated youths, etc. Manufacture of apparatus should be encouraged ; research centres at suitable places under the Central Engineering Council of the central organisation should be established for investigations of problems of broadcasting and radio communication ; well-planned courses of study in electrical communication and broadcasting on the absolutely indispensable

basis of a sound foundation in electrical and mechanical engineering should be inaugurated.

The first and the only satisfactory starting point is for the Central Government to send out under its authority an inquiry commission consisting of a businessman, an educationist of knowledge and experience, a lawyer-statesman and a radio engineer and, if necessary, one or two more members. They should travel extensively, visit stations, studios, radio and allied research laboratories, factories and engineering educational institutions ; they should discuss the various aspects of the problem with engineers, educationists, broadcast administration authorities, politicians, etc. The State should take action on the recommendations of such a commission based on its observation and intensive study of the whole status of broadcasting abroad.

It is hoped that the above will help to create a correct perspective of the vast problem and provoke reasoned discussion on what is inherently a national question. No more extravagant claim is made than that it will offer some concrete basis for such discussion. It is realised that within the limitations of an article in a periodical, it is impossible to go beyond merely scratching the surface of this vast problem.

It is with pleasure that I express my warm thanks to Mr. T. R. Ramachandra Iyer for his very kind assistance so willingly given.

## Asiatic Society of Bengal—Annual Meeting, 1935.

THE Annual Meeting of the Society was held on the 4th February with Dr. L. L. Fermor, O.B.E., D.Sc., F.R.S., President of the Society, in the Chair.

In the course of his Presidential Address Dr. Fermor dealt with the development of scientific research in India. "Starting with the comprehensive treatment of such research provided for by the foundation of the Asiatic Society of Bengal in 1784, the subsequent story has been, until recently, one of increasing specialisation. This specialisation was slow until after the middle of the nineteenth century, when the tendency began to develop force. By the beginning of the twentieth century, rapidly increasing specialisation with the formation of a multitude of new specialist organisations was in full swing. But fortunately at about the same time the necessity for co-ordinating bodies became recognised, and this had led successively to the formation of the Board of Scientific Advice (1902-1924) of the Indian Science Congress Association (1914 to date) and finally of the National Institute of Sciences of India. This final development is in accordance with the genius of our Society, for concurrently with the spate of specialist tendencies and activities, your Society has always maintained its broad general basis, showing its generosity as the mother of new developments often of a specialist nature whilst preserving its position as a philosopher's garden where all may walk and talk."

The following awards were made :

*Elliot Prize for Scientific Research.*—The Prize for the year 1933 was awarded to Mr. N. K. Sen of Dacca University for his contributions to Chemistry. The Prize for 1934 was for Physics and Dr. D. P. Roy Chaudhuri is the recipient of the Prize. The Prize for 1935 will be for work in Geology and Biology (including Pathology and Physiology) regarding which a detailed announcement has been published in the *Calcutta Gazette* and the *Bihar and Orissa Gazette*.

*The Sir William Jones Memorial Medal.*—This medal is awarded biennially for conspicuously important Asiatic researches with reference alternately to (1) Sciences, and (2) Philosophy, literature and history. This year the medal is for Science and has been awarded to Rai Sir Upendra Nath Bramhachari Bahadur, Kt.

*Brühl Memorial Medal.*—This medal is awarded every three years for conspicuously important contributions to the knowledge of the Asiatic Botany. This year the medal is awarded to Mr. I. H. Barkill, Late Director of Gardens, Straits Settlements.

*Indian Science Congress, Calcutta, Prize.*—This prize is awarded in such years as the Session of the Congress is held in Calcutta for conspicuously important services to the Indian Science Congress. The Prize is awarded to Dr. Meghnad Saha, F.R.S., with special reference to his work for the Indian Science Congress.

# Structure of the Nucleus.

By Rao Bahadur Prof. B. Venkatesachar, M.A., F.Inst.P.

FROM ancient times there have been two views of the constitution of matter. One school represented by Democritus considered matter and even space as made up of discrete and indivisible particles or atoms. The other view advocated by Anaxagoras was that matter was continuous and infinitely divisible. The *Nyaya* school in India championed the atomic viewpoint, considering the atoms to be one sixth the size of a mote in a sun-beam. The development of chemistry in the 19th century, beginning with the work of Dalton, placed the atomic theory in an impregnable position. Elements and compounds were distinguished and every element was thought of as made up of similar, indivisible and immutable atoms. Research was concentrated on discovering the various elements and establishing their atomic weights. As late as 1907 Lord Kelvin in his address to the British Association said, "It seems indeed *almost* absolutely certain that there are many different kinds of atoms each eternally invariable in its own specific quality and that different substances such as gold, silver, copper, oxygen, nitrogen, hydrogen, consist each of them of atoms of one invariable quality, and that every one of them is in capable of being transmuted into any other." It was fortunate that Lord Kelvin only said "almost certain"; the small chance to the contrary implied in the word "almost" has been shown by later research to represent the true state of affairs, and our generation has witnessed the successful carrying out of such transmutations as were not dreamt of even by the alchemists of old.

Germs of modern ideas were seen in Prout's hypothesis that all the elements were built up from hydrogen. The fact that the weights of the atoms of various elements were not integral multiples of that of hydrogen was a difficulty which discredited this hypothesis. But the work of Aston has shown that the elements really consist of atoms with different weights all possessing the same chemical properties. These are known as isotopes and the weight of each isotope is almost an integral multiple of that of hydrogen. The difference from an integral value does not disturb our scientific equanimity nowadays. The theory of Relativity has shown that such a difference is a measure of the stability of the atoms. It is an index in fact which shows how any element may be thought of as built up of various constituents and in what direction we may expect a successful transmutation.

In radioactive phenomena nature herself exhibits such transmutations. The study of radioactivity revealed the existence of three different kinds of radiation, *viz.*, the $\alpha$- $\beta$- and $\gamma$-rays. The $\beta$-rays are streams of fast-moving particles of negative electricity, *viz.*, electrons. J. J. Thomson's work on cathode rays established the fact that the electrons were constituents of all atoms, and that their mass was only a minute fraction of that of the hydrogen atom. Thus the problem of the structure of atoms arose and the atoms were no longer conceived as indivisible. $\alpha$-particles were shown to be helium atoms which had lost two electrons, while the $\gamma$-rays were found to be light-waves of extremely short length. Since all atoms are neutral and the electron with its negative charge is part of every atom, how is the other, the positively charged part, constituted? Rutherford's experiments on the scattering of $\alpha$-particles by matter showed that the massive positively charged part of an atom was concentrated into a small compass with the electrons distributed at great distances from this central part or nucleus. The nucleus thus resembles the sun and the planets are represented by the electrons. The number of planetary electrons is determined by the positive charge on the nucleus and the chemical properties of the various elements are determined by the number of these external electrons. The nucleus carries almost the whole of the mass of the atom and is thus characterised by its weight—the atomic weight—, and its positive charge, *i.e.*, the atomic number. This nuclear theory of the atom has been confirmed by all later experience and now rules unchallenged in Physics.

The phenomena of radioactivity show that the nucleus also is composite, and at the present moment the problem of the structure of the nucleus looms large in the scientific work of prominent physicists. The fact that a radioactive element retains its activity whether it is uncombined or combined with other elements, shows that the emission of $\alpha$- and $\beta$- particles must take place from within the nucleus. Thus every nucleus must be supposed to contain $\alpha$-particles and electrons. If $\alpha$-particles are to remain inside

in a stable structure, the electrostatic repulsion between an $\alpha$-particle and the rest of the nucleus must have been converted into an attraction. But Rutherford's experiments on the scattering of $\alpha$-particles of Th(C′) by Uranium, *e.g.*, have shown that Coulomb's law holds up to distances of $3 \times 10^{-12}$ cms. Thus the law of force should be Coulombian repulsion upto distances of this order and then change into one of attraction. Or if we speak of the potential at different distances from the nucleus, it should go on increasing from large distances till at some very small distance it begins rapidly to decrease and then attains a negative value, *i.e.*, the potential curve should show a high peak at some distance from the nucleus. This distance we may speak of as the radius of the nucleus. In the case of Aluminium the distance of this potential peak is estimated to be $4 \times 10^{-13}$ cms. while the height of the barrier is about $7 \cdot 5 \times 10^{6}$ electron volts. In the case of Uranium we have seen that $\alpha$-particles can reach to a distance of $3 \times 10^{-12}$ cms., *i.e.*, the potential barrier must be higher than

$$2Ze^2/_r = \frac{2 \times 92 \times 4 \cdot 77^2 \times 10^{-20}}{3 \times 10^{-12}} = 13 \times 10^{-6} \text{ erg.}$$

But $\alpha$-particles of energy $6 \times 10^{-6}$ erg are emitted by Uranium in radioactive changes. How do these $\alpha$-particles cross a potential barrier of at least twice their energy?

The answer to the above question was given by Gamow on the basis of wave mechanics. According to this point of view every particle must be also supposed to have a wave-like aspect just as light waves behave like particles (photons) in some experiments. Every particle of mass $m$ and velocity $v$ is equivalent to a wave of wave-length $\frac{h}{mv}$. Some experiments like those of G. P. Thomson or Davisson and Germer show the wave-like nature of electrons, while others such as the deflection of cathode rays by electric and magnetic fields show the particle nature of these same electrons. Similarly, interference, diffraction and polarisation show the wave-nature of light, while photo-electricity and the Compton effect show its particle nature. As in the case of Dr. Jekyll and Mr. Hyde, we see sometimes one aspect and sometimes the other, but never both together. According to Gamow's theory the $\alpha$-particles in their wave-aspect can penetrate through the potential barrier and have a finite chance of coming out on the other side. This is one of the triumphs of the new mechanics.

We have already seen that even the nucleus must be complex, containing $\alpha$-particles and electrons. The assumption of free electrons inside the nucleus leads to a number of difficulties in connection with the spin and magnetic moments of nuclei. The discovery of the neutron by Chadwick has helped to remove this difficulty. The neutron is an uncharged particle having a mass nearly equal to that of a proton or hydrogen nucleus and is emitted when Beryllium and Boron are bombarded by $\alpha$-particles from polonium. Being uncharged, it has great penetrating power. Its constitution is not known, but it must be assumed to be capable of giving off an electron or its positive counterpart—the positron—in radioactive processes. The assumption that all nuclei consist of $\alpha$-particles, neutrons and one or no proton according as the atomic number is odd or even removes a number of difficulties such as the one above mentioned regarding the spins of nuclei. Venkatesachar and Subbaraya also showed a way of accounting for the spin and magnetic moments of nuclei. They assumed according to the then current views that a proton has a magnetic moment equal to 1/1845 times that of an electron, but Stern has obtained a value about 2·5 times as much. Though there are still some differences of view regarding details, the general way of accounting for the magnetic and spin moments of nuclei by the spin and orbital motions of the particles inside the nucleus is accepted.

Further progress in the study of the nucleus has been made possible by the discovery of heavy hydrogen (Prof. Urey has received the Nobel Prize in Chemistry for this achievement), and of the positron which has the same mass as the electron but has a charge of opposite kind. Anderson and Neddermeyer and Curie and Joliot have shown that a positron-electron pair results from the materialisation of a $\gamma$-ray in which process the nucleus acts as a catalyst to conserve momentum during the change. Dirac's theory also shows that when a positron and electron unite, two $\gamma$-rays will be produced and this has been observed by Gray and Tarrant. Thus the conversion of matter into radiation and radiation into matter has been accomplished and Einstein's relation between energy and its equivalent mass, *viz.*, $E = mc^2$ has been amply verified.

Another line of enquiry started by Rutherford when he succeeded in transmuting Nitrogen into Oxygen with emission of hydrogen by bombarding Nitrogen with $\alpha$-particles has been followed up in recent years with great success. Almost every element has now been converted into some other and new radioactive elements have been artificially produced by Curie and Joliot and Fermi and others. The missiles at the disposal of the physicist have also multiplied; $\alpha$-particles, protons, diplons (heavy hydrogen nuclei) and neutrons have all been employed for this purpose. Cockcroft and Walton and Lawrence and others have refined experimental technique to such an extent that protons and deutons can now be given energies almost equivalent to that of the $\alpha$-particles provided by Nature and the corresponding progress in the programme of transmutation has been extensive. Thus when $Li_6$ is bombarded by a deuton or $Li_7$ by a proton we get two $\alpha$-particles which have about ten times the energy of the bombarding particles. The internal energy of the nucleus has thus been set free to some extent. Who shall limit the possibilities inherent in this achievement? Gladstone lived to levy a tax on an industry developed from Faraday's discovery. Hertz's discovery has revolutionised modern methods of communication. What practical possibility lying latent in the nucleus may not become an accomplished fact and what revolutions may it not bring about?

## North Bihar Earthquake of January 15, 1934.*

By S. K. Banerji,
*Meteorological Department, Poona.*

THE earthquake which occurred in North Bihar on January 15, 1934, had many important peculiarities. The shock was felt over an area of not less than 3 million square miles—an area which is perhaps greater than that of any earthquake recorded during the last 100 years. An important feature which has been prominently brought to notice is the inequality of propagation of surface vibrations in different directions. These were felt at greater distances towards the south and the west than the north and the east, the Himalayas in the north and the Assam and Burma mountains in the east acting as barriers and damping them out considerably. That these mountain folds and the fault planes which bound them should obstruct the normal propagation of surface waves is what we should expect from the theory of elasticity.

An earthquake of severe intensity has usually an energy of the order of $10^{21}$ ergs but the present earthquake appears to have energy slightly greater than $10^{22}$ ergs. There are several methods by which the calculation of the energy of the earthquake can be made, but the simplest one is to use the results obtained theoretically by Nakano that for an earthquake of shallow focus 0·4 of the energy sent out from a compressional disturbance and 0·9 of that from a distortional one goes into surface waves. If then we estimate by means of seismograms the velocity of ground movements at some fixed distance, say 200 km., all round and also estimate the length of the wave train carrying most of the energy, we can immediately calculate the total energy of the earthquake. To illustrate the method of calculation, we would estimate that the mean velocity at a distance of 200 km. was 250 cm/sec. Since the mean density of surface rocks is about 2·7, the kinetic energy per unit volume is $9 \times 10^4$ ergs. On the average the potential energy is the same as the kinetic energy, and, therefore, the total energy per unit volume is $1·8 \times 10^5$ ergs. Now the length of the part of the wave train carrying most of the energy

= mean velocity of surface waves × time taken to pass over a given place

$= 4 \times 10^5 \times 10 \times 60 = 2·4 \times 10^8$ approximately.

Integrating over a circle of radius 200 km., we see that the energy of surface vibrations $= 1·8 \times 10^5 \times 2·4 \times 10^8 \times 1·2 \times 10^8 = 5 \times 10^{21}$ ergs.

According to the results obtained by Nakano, this is only a fraction of the total energy. Taking dissipation and other factors into account it would seem that the total energy is slightly greater than $10^{22}$ ergs. It is easily seen that this estimate of the total energy is not much affected, if we estimate a slightly greater or smaller value for the velocity

* Based on the opening speech at the symposium held at the Indian Science Congress, 1935.

or the duration of the length of wave train or both at a distance of 200 km.

An energy of the order of $10^{22}$ ergs could be produced by the fracture of a quadrangular rock of dimensions 150 km. × 100 km. and thickness 10 km. If $a$ be the length, $b$ the breadth, and $2h$ the thickness of a quadrangular rock, then its potential energy when bent by couples is

$$\frac{1}{3}\,\frac{Eh^3}{1\cdot\sigma^2}\left[\left(\frac{1}{R_1}+\frac{1}{R_2}\right)^2-2\,(1-\sigma)\,\frac{1}{R_1R_2}\right]ab$$

where $R_1$, $R_2$ are the radii of curvature, E the Young's modulus and $\sigma$ the Poisson's ratio. When the rock cracks, this energy is released. It is important to notice that this expression involves thickness in the third power but the length and breadth only in the first power. It is, therefore, the thickness which contributes most to the amount of energy released. We have no observational evidence in regard to the amount of bend which a plate of rock of large dimensions can stand before rupture, but, according to definition, if O is the centre of the rock, and if a plane through the normal and a principal axis of the indicatrix cut the extremities of the rock in the diameter QVQ′, then the radius of curvature R is given by $2R\cdot OV = QV^2$. But QV is either 75 km. or 50 km. according as the plane passes through the major or the minor axis of the indicatrix. It would be safe to assume that the rock will crack if OV become as large as 100 metres† (Fig. 1). This would make $R_1$ and $R_2$ to be of the order $10^{10}$ cm. and $10^9$ cm. respectively. With these values for $R_1$ and $R_2$ it is easily seen from the formula that the amount of energy which would be released by a bent quadrangular rock of dimensions 150 km. × 100 km. × 10 km. is of the order of $10^{22}$ ergs. If the thickness was less than 10 km., its length and breadth would have to be considerably greater than 150 km. and 100 km. respectively in order to give the energy of this magnitude. This would suggest that the focus of this earthquake must have covered a wide volume and the epicentral tract a fairly wide area. This is confirmed by the observations[1] made by the Geological Survey.

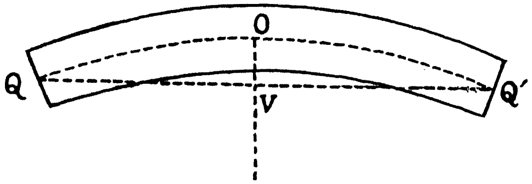



**Fig. 1.**

The very great preponderance of surface waves in this earthquake, as well as the type of movements in the preliminary and the secondary phases all suggest that this earthquake had a shallow focus.[2] If we estimate the depth of focus from the relative importance of the different phases in the seismogram, we find that its upper surface was probably not lower than 15 km. From an analysis of the 'delay in starting' of the phases $\bar{P}$, P*, P, $\bar{S}$, S*, S, Ray[3] has recently estimated the depth of focus to be about 13 km. With this information in our possession, the question arises whether the theory of elasticity can make any definite contribution to the search for the cause of this earthquake.

It is almost certain that isostatic compensation holds in the case of such large mountains as the Himalayas. For, suppose that compensation did not hold, and that the Himalayas could be supported by the strength of the crust and the substratum. Calculation by the method given by Love[4] shows that the stress differences required to support mountains of height 10,000 metres above the adjacent valleys in a uniform crust would be about $10^9$ dynes/cm.$^2$ This is near the crushing strength of basalt, which could, therefore, just support the Himalayas if the stresses necessary could be distributed over an infinite depth. The Himalayas apart from being very high are of such large horizontal extent that they would produce breaking stresses in the lithosphere assumed to be of finite thickness. It is therefore very likely that they are bounded by fault planes so that they can move up and down independently, that is to say, float on the lithosphere and undergo up and down movements without disturbing the

† Surface earthquake waves which usually have wave-lengths of 60 or 70 km. invariably cause extensive cracks if they have amplitudes as large as one metre. The estimate of 100 metres for OV would thus appear to be an overestimate and not an underestimate. A smaller value for OV would require greater thickness for the rock to yield the same energy.

[1] *Rec. of the Geological Survey*, 1934, **38**, 177.

[2] *Phil. Mag.*, 1925, **49**, 65.

[3] *Curr. Sci.*, 1935, **3**, 298.

[4] ***Some Problems of Geodynamics***, pp. 38–48; ***Jeffrey's Earth***, pp. 178-202.

surface crust over the continents. But can relationship between the mountains and the continent be so simple as this? The fault planes being planes of fractures are probably inclined to the vertical. A clear gap does not apparently exist. There are probably huge rocks connecting the mountains and the continents across the fault planes. Any upward or downward movement of the mountains will necessarily introduce considerable stress in these rocks and if the elastic limit is reached, breaking will occur. Was a process like this the cause of the present earthquake? The upward motion of the mountains can of course occur as a consequence of denudation and if they are floating more or less independently of the continents the gravity anomalies found in the Gangetic plain and elsewhere are probably not of much importance as undoubtedly the strength of the continental crust, *i.e.*, the cohesion of the materials forming the continental crust, is able to support a small departure from perfect isostacy.

A theory of the above kind can only stand if it can be supported by geological observations. Such observations[5] have shown that the main epicentral tract has the form of an elongated ellipse and that it is situated at a distance of about 35 km. from the boundary fault (Fig. 2). If P be the greatest principal stress at any point in a rock and R be the least, the fault planes will, according to the theory developed by Mohr, Navier and others, be inclined at angle $\theta$ to the direction of P, given by $(P - R)(\sin 2\theta + \mu \cos 2\theta) - \mu(P + R) =$ a maximum. This equation means that along the planes of fracture the tangential stress diminished by the resistance to movement which is due to internal friction must be maximum, and gives $\theta = 22\frac{1}{2}^\circ$ for $\mu = 1$. This result[6] is supported by observations, for, in the case of normal faulting it is known that P is very nearly vertical and R horizontal, and that normal faults are inclined to the vertical at an angle slightly greater than $22\frac{1}{2}^\circ$. The faults cannot, however, be along a straight line, such as OA (or OA'

[5] *Rec. of Geological Survey, ibid.*

[6] *Beiträge Zur. Geophysik*, 1931, **43**, 5.

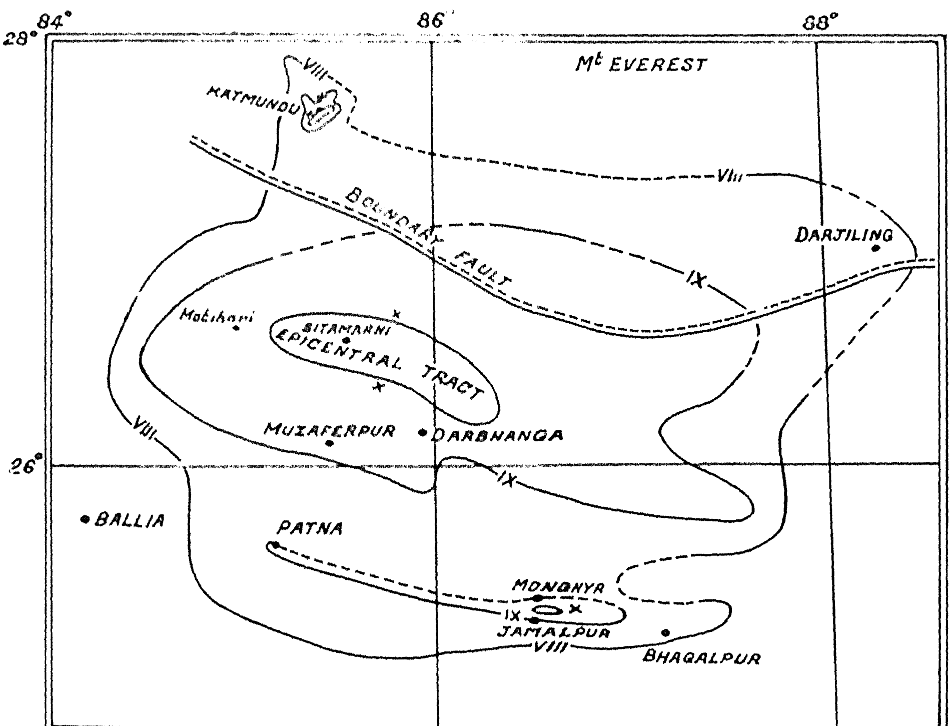



**Fig. 2.**

Epicentral Tract, isoseismal lines and boundary fault (Based on the *Report of Geological Survey of India*).

if $\theta$ has a greater value than $22\frac{1}{2}°$) (Fig. 3).

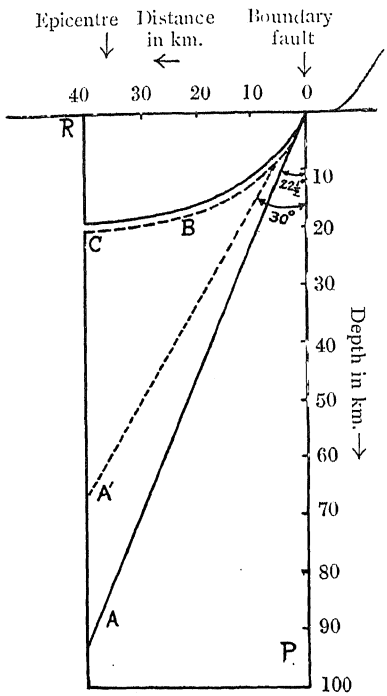



**Fig. 3.**

Vertical Section through epicentre and nearest point of boundary fault.

For, observations as well as theory of fractures[7] produced by loading always indicate that they lie along a curve such as OBC. The depth of the faults below the observed epicentral tract will therefore be about 20 km., and if an elongated rock of dimensions 150 km. × 100 km. and thickness 10 km. (rectangular, elliptical or other shape) was lying across the fault at this depth and was strained, it could by fracture give the energy required for the production of the earthquake. The two subsidiary epicentral tracts near Khatmando and Monghyr were probably induced by a major crack of this kind.

The earthquake occurred on a new moon day, and on such a day we get a body tide due to the elastic yielding of the solid material of the earth, such that the height of the oceans, as measured by the rise and fall of the sea, relative to the land is reduced to about $\frac{2}{3}$ of the true equilibrium height (if the rigidity of earth be assumed to be the same as that of steel). On that day also an atmospheric disturbance was passing over Northern India and Darwin has shown that if the difference of barometric pressure between consecutive regions of "high" and "low" pressures be 5 cm. of mercury and if the centres of "high" and "low" be 1,500 miles apart, then as a consequence of the yielding of the ground, it will be 9 cm. higher under the barometric depression than under the elevation. These causes could, therefore, conceivably have served to produce a kind of trigger action.

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# Some Recent Advances in Indian Geology.*

By W. D. West,
*Geological Survey of India.*

## 5. The Geology of Salt Range.

THIS comparatively small range of mountains in the northern Punjab has long been regarded as the show locality of Indian geology. Its fairly complete geological record, its abundant fossils and its complicated structure have combined to make it a place of great attraction to geologists. Bound up with the correct interpretation of its structure is the question of the age of the Saline series, concerning which almost every geologist who has visited the Salt Range seems to have propounded a theory. The problem, it will be recollected, lies in the fact that while in the Salt Range the Saline series underlies rocks of Cambrian (or possibly pre-Cambrian) age, in the Kohat district, only 17 miles away, it underlies rocks of Upper Nummulitic (Middle Eocene) age. And since in the latter place it was considered by D. N. Wadia and L. M. Davies to be of lower Eocene age,[1] a view subsequently corroborated by E. R. Gee,[2] its stratigraphical position in the Salt Range was difficult to understand.

There is no need to summarise the early stages of this controversy. Suffice it to say that Sir Edwin Pascoe, as a result of his

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[7] Banerji, *Bulletin Cal. Math. Soc.*, 1921, **12**, 93.

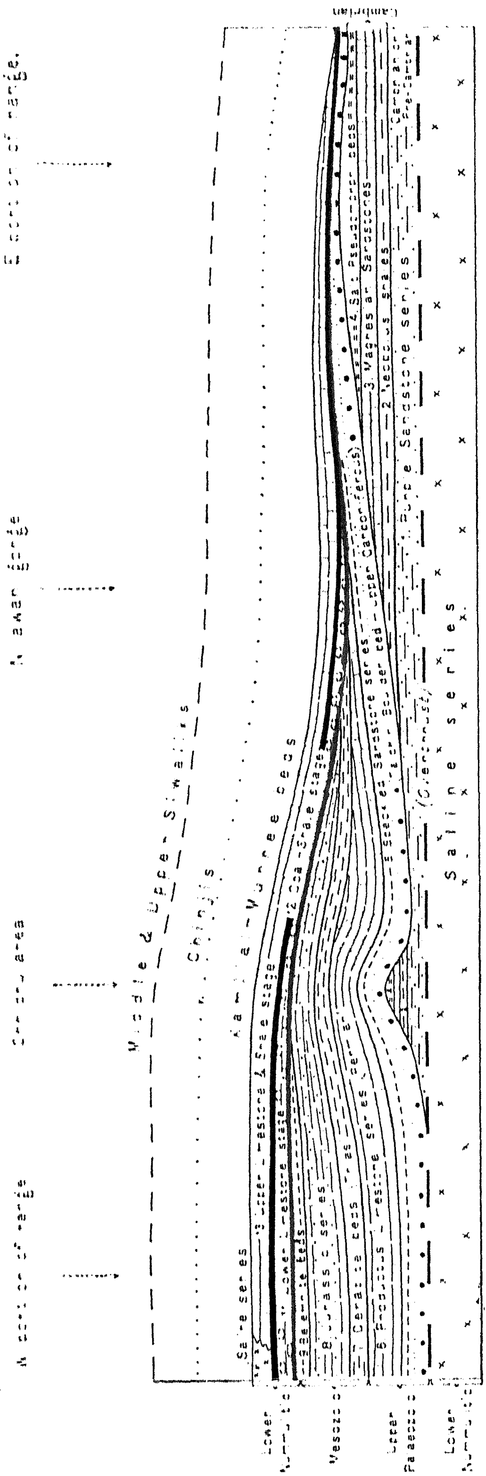
* Published with the permission of the Director, Geological Survey of India.

[1] *Trans. Min. Geol. Inst. Ind.*, 1929, **24**, 202.

[2] *Rec. Geol. Surv. Ind.*, 1931, **65**, 20; and *Curr. Sci.*, 1934, **2**, 461.

studies of the oil-bearing strata of north-western India, suggested a Tertiary age for the salt deposits of both the Salt Range and the Kohat area. This view necessitated the introduction of an overthrust between the Saline series of the Salt Range and the overlying Cambrian beds.[3] The chief objection to this view was that no Salt Marl had been found in the Tertiary rocks of the higher parts of the Salt Range. Subsequently C. S. Fox, as a result of a visit to parts of the range, gave reasons for reverting to the Cambrian age of the salt,[4] a view which also received some support from the fact that salt deposits were found in Persia associated with Cambrian rocks.[5] More recently, G. de P. Cotter, after first accepting a Cambrian age as probable on the balance of evidence,[6] has now supported the view that the Saline series is of Ranikot age, suggesting that its place of original deposition was in the Soan geosyncline to the north of the Salt Range, and that during folding movements associated with the final uplift of the range and of the Kala Chitta hills some of the salt marl was intruded southwards into its present position beneath the Cambrian beds.[7] It has to be admitted, however, that owing to the thick covering of upper Tertiary rocks in the Soan geosyncline of the Potwar, the Saline series is nowhere seen *in situ* in its supposed original position beneath the Laki beds.

In the midst of so much speculation it is refreshing to know that during the past six years a careful re-survey of the Salt Range has been carried out by E. R. Gee whose mapping has been continued westwards across the Indus to link up with the *trans* Indus ranges and with the Kohat salt region to the north. A summary of the conclusions that have resulted from this survey has, in so far as the Saline series is concerned, already been published in *Current Science*. In this Gee maintains that the Saline series of the Salt Range area is essentially *in situ*, and that the deposit is homotaxial with that of the Kohat salt region and with the Nummulitic limestone and shale deposits of Lower Eocene age which cover wide areas in north-western India.



SKETCH SECTION SHOWING DISTRIBUTION OF SEDIMENTS IN THE CIS-INDUS SALT RANGE.
(The red line represents the Lower Eocene ferruginous pisolite).
By E. R. Gee.

[3] *Mem. Geol. Surv. Ind.*, 1920, **40**, 358-371.
[4] *Rec. Geol. Surv. Ind.*, 1928, **61**, 117.
[5] *The Structure of Asia*, 1929, **3**.
[6] *Proc. Eighteenth Ind. Sci. Congr.*, 1931, 295.
[7] *Mem. Geol. Surv. Ind.*, 1933, **55**, 149-156.
[8] *Curr. Sci.*, 1934, **2**, 460-463.

To make clear the latest views on the stratigraphy of the Salt Range, a diagrammatic section showing the general geological sequence is given, for the construction of which I am much indebted to Mr. Gee. In this simplified section, taken roughly along the length of the range, the lateral variations in the sequence are indicated. Two marked unconformities are shown. One separates the Lower Palæozoic from the Upper. Along this line the Talchir boulder bed (Upper Carboniferous) overlaps successively westwards across the Salt Pseudomorph beds, the Magnesian Sandstone and the Neobolus Shales on to the Purple Sandstone strata, and finally, as a result of overthrusting, comes to rest directly on the Saline series of the western part of the range. This unconformity with overlap has been discussed by R. D. Oldham and C. S. Middlemiss.[9] That the overlap is less regular than was previously supposed has recently been pointed out by Gee, local exposures of the fossiliferous Cambrian beds cropping up around Chhidru in the western half of the range.[10]

The second large unconformity, first recognised by A. B. Wynne, occurs beneath the Eocene nummulitic rocks. It is marked by a thin irregular bed of ferruginous shale, often pisolitic, which evidently represents an old land-surface. In the extreme east this ferruginous pisolite rests on Talchir shales, in the middle portion of the range it overlies the Productus Limestone, while in the western half it lies on various horizons of the Mesozoic rocks. The nummulitic rocks above the unconformity were, until recently, regarded by most observers to be Laki in age. It has now been discovered that at least the lower portion of the sequence is Ranikot in age.[11]

A third unconformity, less marked in the field than those above-mentioned, but none the less important, is represented by the junction of the Murree Kamlial beds with the underlying Nummulitic Limestone.[12] This unconformity was thought by earlier workers to represent the whole of the Oligocene; recent work by Pilgrim, Cotter and Lahiri has enabled its limits to be more clearly defined.[13]

Regarding the exact age and correlation of the various rock groups, much palæontological work still remains to be done. Recent fieldwork by Gee, however, has shown the close relationship in age between the Neobolus Shales, the Magnesian Sandstone and the Salt Pseudomorph beds, all of which are probably Cambrian.[14] As regards the underlying Purple Sandstones, Fox has stated that they are conformably overlain by the Neobolus Shales, and he places both in the Middle Cambrian.[15] Gee has found in places that the Neobolus Shales rest with a thin basal conglomerate on the Purple Sandstones, and he regards the latter as Cambrian or pre-Cambrian. No fossils have so far been found in them.

Coming now to the Upper Palæozoic rocks, plant remains of lower Gondwana type have been found by Gee in shales overlying the Talchir boulder bed,[16] whilst higher in the sequence, in similar carbonaceous shales among the lower half of the Productus Limestone, Cotter had previously discovered Gangamopteris and Glossopteris.[17] The Warcha section of the Productus Limestone has been described by Cowper Reed, Cotter and Lahiri.[18] In the Jurassic beds, which include a thick sequence in the western part of the Salt Range and which are also well represented in the *trans* Indus ranges, an Upper Gondwana flora has recently been found by Gee.[19]

It will be remembered that the Nummulitic series (of which only the lower half is represented in the Salt Range) includes the Salt Range coal seam in the eastern half of the range, where the seam occurs not far above the ferruginous pisolite. Traced westwards, however, thick nodular foraminiferal limestones come in below the coal, while the latter passes into a carbonaceous shale, as originally described by Wynne. In the western part of the Salt Range, however, near Daud Khel, exposures showing the lateral passage of the upper limestone (above

[9] *Rec. Geol. Surv. Ind.*. 1886, **19**, 127-131; and *op. cit.*, 1891, **24**, 21-24.

[10] *Op. cit.*, 1234, **68**, 115-120.

[11] Director's Annual Report for 1934 (in the press).

[12] *Mem. Geol. Surv. Ind.*, 1933, **55**, 101-104.

[13] *Rec. Geol. Surv. Ind.*, 1910, **40**, 185; and *op. cit.*, 1933, **43**, 264, and reference 12 above.

[14] *Op. cit.*, 1934, **68**, 115.

[15] *Rec. Geol. Surv. Ind.*. 1928, **61**, 147.

[16] *Op. cit.*, 1933, **67**, 22.

[17] *Op. cit.*, 1930, **62**, 443.

[18] Reference 16, 412-443.

[19] *Op. cit.*, 1929, **62**, 163.

the coal-shale stage) into massive gypsum have recently been discovered by Gee, together with evidence indicating the passage of the underlying coal shale stage into salt-bearing marl.[20] Both the gypsum and the marl belong to the Saline series. It is concluded, therefore, that the Saline series of the Salt Range (and of Kohat) represent local saliferous facies of Lower Nummulitic (Lower Eocene) sedimentation. This critical section, which appears to have been overlooked by previous observers, apparently provides decisive evidence regarding the age of the Saline series.*

Above the Nummulitic series of the Salt Range the middle and upper Tertiary fresh water strata cover wide areas northwards across the Potwar plateau and the Kohat area, and to the west. These sediments, the vertebrate fauna of which has been studied by G. E. Pilgrim, have recently been studied in detail by R. van V. Anderson and by Cotter and Lahiri.[21]

Regarding the structure of the Salt Range, opposing views have been put forward. Some geologists have interpreted the observed relations of the rocks as being due to overthrusting.[22] C. S. Fox, on the other hand, has endeavoured to explain these structures without the assistance of dynamic forces, attributing them to isostatic movements which have resulted from a relatively plastic salt marl having underlain the higher strata of the Salt Range.[23] Gee, however, appears to be convinced that at least the larger folds, overfolds and thrusts are definitely of tectonic origin.[24] In order to explain the presence of the Saline series beneath the Lower Palaeozoic rocks of the range, he postulates an immense regular thrust along which the rocks have moved towards the south in the Salt Range and towards the east in the *trans* Indus ranges in post-Nummulitic and pre Siwalik times (*i.e.*, late Eocene and Oligocene), involving a movement of not less than 20 miles. The *nappe* involved in this primary thrust included the Nummulitic and underlying rocks of the Potwar, Kohat and Bannu areas, and continued further afield to link up stratigraphically with the rocks of what are now the Himalaya and Sulaiman ranges. He thinks that a second period of acute tectonic movement commenced in the late Tertiary and continued into sub-Recent times, the forces coming from the same northerly and westerly directions. Owing to the fact that the Salt Range and *trans*-Indus rocks had already, at the time of this second period of earth-movement, approached closely to the Archaean *massif* to the south, of which remnants are now exposed in the Kirana hills, further movement towards the south was impeded, and the forces were spent in causing the acute folding and duplication by overfolding and shearing of the Salt Range strata. During this second period of earth-movement the Saline series was lying beneath the beds of the primary *nappe* and was therefore folded and sheared along with the latter as though it were a portion of a normal stratigraphical sequence. It is in this way that he explains the intimate relationship of the Saline series and the Palaeozoic rocks of the Salt Range. A fuller account of these conclusions regarding the age of the Saline series has already appeared in *Current Science* for June, 1934.

### 6. Epilogue.

In bringing to a close this series of short articles outlining the main lines along which recent work in Indian geology has been developing, I may refer very briefly to certain researches which for various reasons I have omitted to discuss. Chief among these is the recent work which has been carried out on the geology of the Gondwana system. This has been done in the main by C. S. Fox and H. Crookshank, who have added considerably to our knowledge of this important period of Indian geology. For a general account of the geology of these rocks the reader is referred to Fox's recent memoir on the Gondwana system,[25] which forms a part of this great work on the coalfields of India; while the Gondwana rocks of part of the Satpura hills in the Central Provinces have been described by Crookshank in a memoir which is now in the press.[26] Perhaps the most interesting

[20] *Curr. Sci.*, 1934, **2**, 460-461.

* In a paper read by Messrs. P. Evans and M. A. Majeed, of the Burma Oil Co., Ltd., at the recent meeting of the Indian Science Congress, further evidence, based on the examination of heavy mineral residues, was brought forward in support of the Tertiary age of the Saline series of the Salt Range.

[21] *Bull. Geol. Soc. Amer.*, 1928, **38**, 665; and *Mem. Geol. Surv. Ind.*, 1923, **55**, 99.

[22] *Mem. Geol. Surv. Ind.*, 1920, **40**, 358-371.

[23] Reference 15.

[24] Reference 8.

[25] *Mem. Geol. Surv. Ind.*, 1931, **63**.

[26] *Op. cit.*, **66**, Part 2 (in the press).

discovery in Gondwana geology has been the find by K. P. Sinor near Umaria in Central India of a marine fauna in rocks which had hitherto been regarded as wholly continental in origin.[27] These rocks were subsequently mapped by E. R. Gee,[28] and the fossils found in them described by F. R. Cowper Reed.[29] Reference should also be made to Sir Thomas Holland's presidential address to the Geological Society of London in 1933, wherein he discusses comprehensively the evidence bearing on the age of the glacial phase at the beginning of the Gondwana period.[30] Finally a general discussion from the palæontological standpoint of the question of land bridges in Gondwana times has been given by C. Schuchert[31]; while A. L. du Toit, a supporter of the hypothesis of continental drift, has discussed the classification of the sediments of Gondwana times and the question of the boundary between the Carboniferous and the Permian.[32]

I have in these articles made little reference to recent work on the general structure of India, except indirectly in the sections dealing with the Himalaya. Attention, however, may be drawn to two papers which are of importance. The first contains a discussion by Dr. L. L. Fermor on the origin of the Aravalli range.[33] In this it is concluded that there was an original fold-range in pre-Vindhyan times which was largely eroded before the deposition of the Vindhyans (? Cambrian), and that this range was subsequently rejuvenated as a horst bounded by faults in post-Vindhyan times. Thus its present aspect as a mountain range is regarded by Dr. Fermor as younger than had hitherto been thought and not directly connected with the original folding. The second paper is by E. A. Glennie, and deals with the data provided by the geodetic investigations of the Survey of India.[34] This is an illuminating paper, for it marshals the geodetic evidence in such a way as to throw light from a new angle on many problems of Indian geology. And though it seems that there is still a long way to go before the observed facts of geology and the geodetic evidence can be satisfactorily correlated, the paper is one which should be read by everyone taking an intelligent interest in the broader aspects of Indian geology and in general problems of earth history.

In conclusion, it can, I think, be claimed that the advances which have been made in our knowledge of the geology of India during the past decade, which I have attempted to outline in the preceding articles, have been very considerable. If any general conclusion can be drawn from a survey of this work, it is perhaps that recent work has for the most part demonstrated the soundness of the foundations which were laid 60 and 70 years ago by the pioneers of Indian geology, chief among whom were H. B. Medlicott and W. T. Blanford. Much of this early work had a significance which extended beyond the boundaries of India. Whether the same can be said for the more recent work time alone can tell.

Finally, I express my thanks to Dr. Fermor for reading through the whole of these articles, and for offering a number of valuable suggestions.

"*The man who makes no mistakes does not usually make anything.*" EDWARD J. PHELPS.

[27] *Rec. Geol. Surv. Ind.*, 1922, **54**, 14, *Bull No. 2, Geol. Dept., Rewah State*, 'Rewah State Coalfields' 1923, 1-22.

[28] *Rec. Geol. Surv. Ind.*, 1928, **60**, 399.

[29] *Op. cit.*, 367.

[30] *Quart. Journ. Geol. Soc.*, 1933, **89**, 64.

[31] *Bull. Geol. Soc. Amer.*, 1932, **43**, 875.

[32] *Rept. XVI Intern. Geol. Congr. Washington*, 1933.

[33] *Rec. Geol. Surv. Ind.*, 1930, **62**, 391.

[34] Survey of India, Professional Paper No. 27, 1932.

## Obituary.

WE regret to announce the sudden death of Dr. Ganes Prasad, M.A., D.Sc., Hardinge Professor of Higher Mathematics, Calcutta University, on the 9th inst. Dr. Prasad was a prominent educationist, a well-known mathematician and one of the founders of the Agra University.

# Letters to the Editor.

## The Photo-dissociation of Single Crystals of Potassium and Sodium Nitrates under Polarised Light.

IN a previous communication[1] by Mr. Guha and one of us it was suggested that the well-known absorption bands of inorganic nitrates in the ultra-violet, having their long wave-length limits at about 350 $m\mu$ and 230 $m\mu$ respectively, may be attributed to the following photo-dissociations:

$NO'_3 \rightarrow NO'_2 + O\ (^3P)$  81 kilocals. (350 $m\mu$)

$NO'_3 \rightarrow NO'_2 + O(^1D_2)$  124 kilocals. (230 $m\mu$)

The observation with single crystals of $KNO_3$, $NH_4NO_3$, $NaNO_3$, etc., in which the $NO'_3$ ions are all oriented parallel to one another, that both the absorption bands are strongly polarised, the ordinary rays being absorbed much more strongly than the extraordinary rays, was interpreted as indicating a corresponding difference between the photo-dissociative activities of the two rays.

We have recently made some experiments on the photo-dissociation of solid inorganic nitrates, particularly with a view to testing the above conclusions. The following are the main results obtained:

(1) All the nitrates studied, namely those of K, Na, $NH_4$, Sr, Ba, Al, Cd and Pb, showed definite dissociation under the action of light (from a quartz mercury lamp) of wave-lengths shorter than about 250 $m\mu$ (region of the stronger absorption band), as tested by the formation of nitrite. The actual long wave-length limit of the photo-active region of the spectrum was not determined.

(2) The dissociation appears to be confined to a thin surface layer of the crystal, about 20$\mu$ thick. The absence of permanent dissociation in the interior is attributable to the recombination of the products of dissociation.

(3) Experimenting under linearly polarised light (obtained by passing the light from the arc through a quartz double-image prism), with single crystals of $KNO_3$, $NH_4NO_3$ and $NaNO_3$, it was found that the dissociation is much greater when the electric vector of the exciting light is in the plane of the $NO'_3$ ions (ordinary ray) than when it is along the normal to their planes.

(4) $KClO_3$ crystals also show a similar anisotropic photo-dissociation.

K. S. KRISHNAN.
L. K. NARAYANASWAMY.

210, Bowbazar Street,
Calcutta,
*February* 25, 1935.

[1] *Curr. Sci.*, 1933, **2** 476; *Proc. Ind. Acad. Sc.*, 1934, **1**, 242.

## Absorption Spectra of Sulphur-Chlorides and -Oxychlorides in the Vapour State.

IN continuation of previous work already reported,[1] it was found necessary to study the absorption spectra of the series of compounds $SCl_2$, $S_2Cl_2$, $SOCl_2$ and $SO_2Cl_2$. This work is now complete and we present a summary of the results obtained.

[1] *Curr. Sci.*, 1934, **2**, 433.

| Substance | A | | B | | | C | | | D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *a* | *b* | *a* | *b* | *c* | *a* | *b* | *c* | *a* | *b* | *c* |
| $SCl_2$ | 5825 | 5165 ? | 4550 | 3860 | 3700 | 2770 | 2610 | 2450 | 2350 | 2280 | 2260 |
| $S_2Cl_2$ | | | | | | 2770 | 2580 | 2390 | | | |
| $SOCl_2$ | | | | | | 2900 | 2450 | 2400 | | | |
| $SO_2Cl_2$ | | | | | | | | | 2600—continuous | | |

*a* gives the beginning, *b*, the maximum and *c*, the end of absorption in wavelengths (A. U. in air).

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27 *Rec. Geol. Surv. Ind.*, 1922, **54**, 14, *Bull No.* 2, *Geol. Dept., Rewah State*, 'Rewah State Coalfields' 1923, 1-22.

28 *Rec. Geol. Surv. Ind.*, 1928, **60**, 399.

29 *Op. cit.*, 367.

30 *Quart. Journ. Geol. Soc.*, 1933, **89**, 64.

31 *Bull. Geol. Soc. Amer.*, 1932, **43**, 875.

32 *Rept. XVI Intern. Geol. Congr. Washington*, 1933.

33 *Rec. Geol. Surv. Ind.*, 1930, **62**, 391.

34 Survey of India, Professional Paper No. 27, 1932.

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# Fertile Pedicelled Spikelets in Sorghum.

By G. N. Rangaswami Ayyangar, B.A., I.A.S.,
*Millets Specialist, Agricultural Research Institute,*
and
V. Panduranga Rao, M.A.,
*Assistant, Millets Breeding Station, Coimbatore.*

SORGHUM grains develop in sessile hermaphrodite flowers. The sessile flowers have normally attached to them at least one pedicelled flower. These pedicelled flowers have the usual floral envelopes or occasionally, vestiges thereof. They are not usually obtrusive; however, in a few varieties they are prominent and give the ear-head a prickly look. They serve as a padding between the sessile flowers. Sometimes there are two pedicelled flowers one on each side of the sessile. In stray cases sessiles without pedicelled flowers attached to them occur. Sessiles with three pedicelled spikelets are a rarity. Almost all pedicelled spikelets are barren. In the terminal spikelets, where these are in pairs, odd flowers bear anthers. Long,[1] after an extensive examination of the spikelets of *Andropogon halipensis* and *Andropogon Sorghum*, var. *sudanensis*, comes to the conclusion that the aborted pistil of the pedicelled flower suggests that it once had a perfect flower.

An intense botanical examination of the varieties of sorghum at the Millets Breeding Station, Coimbatore, showed three varieties which had pedicelled flowers with seeds (Illustration): A.S. 3441 and M.S. 2687 (from East Africa), and M.S. 1644 (from Bihar). In the two sorghums from Africa all the pedicelled spikelets had both anthers and ovaries at flowering time but not all ovaries developed grains. The analysis of a head in each showed as follows:—

| | Total number of pedicelled spikelets with ovaries | Number of pedicelled spikelets with grains | Percentage of grain formation in pedicelled spikelets |
|---|---|---|---|
| A.S. 3441 .. | 2,683 | 1,647 | 61 |
| M.S. 2687 .. | 4,274 | 945 | 22 |

In M.S. 1644, the Indian variety in which the manifestation of this fertility was very poor, 40 heads were analysed and the incidence of grain-bearing pedicelled spikelets was noted. Twenty-five heads showed under one per cent., ten heads two to three per cent. and five between four and eight per cent. of grain-bearing pedicelled spikelets. The rest of the pedicelled flowers were antheriferous.

The seeds from pedicelled spikelets were normal but smaller than those in the sessile spikelet. Weights of 200 grains showed them to be half the weight of grains from sessile flowers. This halving in size is in consonance with the disability of being pedicelled. Germination tests proved them to be as viable as normal grains.

The distribution of the hermaphrodite pedicelled spikelets in the successive whorls from bottom to top of the panicle was gone into and it showed that there was a progressive increase towards the top. In M.S. 2687 it rose from 5 to 21 per cent., in M.S. 1644 from 4 to 33 per cent. and in A.S. 3441,

Sessile spikelet with pedicelled grain-bearing spikelet attached. ×3.

the African variety which had the largest manifestation of pedicelled hermaphrodites, it was 53 to 85 per cent. In the terminal sessile spikelets, where the pedicelled flowers are mostly in twos, one or both developed seeds. It can be said that generally all the spikelets towards the periphery of the panicle produce grains. Those towards the centre of the ear-head fail to set seeds. Pedicelled

[1] *Bot. Gaz.*, 1930, **89**, 154.

flowers with ovaries only and no anthers were not met with.

The pedicelled flowers, when they are antheriferous, start opening at about the close of the main wave of the anthesis of sessile hermaphrodite flowers (G. N. Rangaswami Ayyangar and V. P. Rao, 1931).[2] The hermaphrodite pedicelled spikelets, however, flower *along with* the sessile flowers. The second wave of anthesis, usually met with in those sorghums which have antheriferous pedicelled spikelets, is absent in the case of panicles in which both sessile and pedicelled spikelets are hermaphrodite.

In all the three cases reported above, it is noticeable that this phenomenon of hermaphrodite pedicelled spikelets occurred in varieties in which the size of grain in the normal sessile hermaphrodite is distinctly smaller than the average grain in Grain Sorghums. It has been noted that in pedicelled spikelets the grains were about half the size of those in the sessile ones. This smallness in small grained ear head gives the panicle in which this phenomenon is recorded, a minuteness of grain disposition, not usual in this Great Millet.

The occurrence of grains in pedicelled spikelets opens up the possibility of breeding an all-fertile ear-head in spite of the [illegible] drag of the sterility of pedicelled flowers which characterises the Andropogons. The smallness of grain is a disability to be faced. A big grain is a desideratum in a Grain Sorghum. Crosses designed to explore the possibilities of this combination are in progress.

Above all the concurrent flowering of the hermaphrodites whether pedicelled or sessile, without falling back as a second wave as in the case of pedicelled antheriferous spikelets, leads to the possible relationship of factors responsible for the opening of flowers and the part that a full sexual complement plays in that process.

# Abnormal Fruits—Viviparous Germination in *Coccinia indica* W & A. (Family *Cucurbitaceæ*).

By M. Ghouseuddin and M. Sayeeduddin,
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THE object of this note is to record a rather advanced stage of what is called viviparous germination in *Coccinia indica*. One of the authors, M. Ghouseuddin, collected a few fruits from a plant growing near the tank in the Public Garden, Hyderabad. They show viviparous germination in a very advanced stage in that a tendril and a leaf have found their way out of the fruits (Fig. 1).

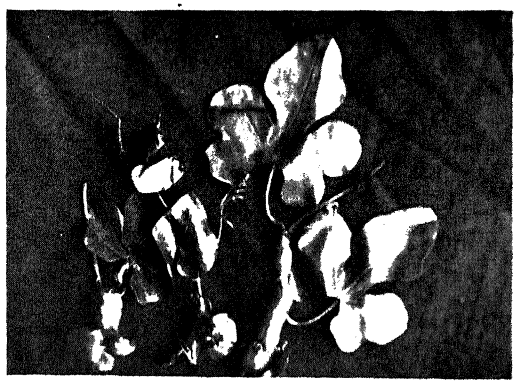

**Fig. 1.**
Fruits—*Coccinia indica* Viviparous Germination.

Viviparous germination has been recorded in the family *Cucurbitaceæ*, *viz.*, in melon in a considerable detail by Sir Thiselton-dyer. But in the specimens he has described the seedlings were still within the fruit and could not penetrate the fleshy and solid pericarp to find their way out. Only in one instance did he find a tap-root actually penetrating the solid parenchyma of the pericarp. The cotyledons were green but the chlorophyll came out in alcohol very readily, and did not impart good enough colouration to the alcohol.

Viviparous germination has long been known in Mangroves (*Rhizophoraceæ*), and it often occurs in *Citrus* fruits, *Carica Papaya*, *Dipterocarpus retusus* (*Dipterocarpaceæ*), *Bertholletia excelsa* (*Lecithydaceæ*), etc. But as far as we are aware, cases have not been recorded in which the seedlings were so well developed as in this case; the shoot comes

[2] *Ind. J. Agri. Sci.*, 1931, 1, 445.

# Letters to the Editor.

## The Photo-dissociation of Single Crystals of Potassium and Sodium Nitrates under Polarised Light.

IN a previous communication[1] by Mr. Guha and one of us it was suggested that the well-known absorption bands of inorganic nitrates in the ultra-violet, having their long wave-length limits at about 350 $m\mu$ and 230 $m\mu$ respectively, may be attributed to the following photo-dissociations :—

$NO'_3 \rightarrow NO'_2 + O\ (^3P) - 81$ kilocals. (350 $m\mu$)

$NO'_3 \rightarrow NO'_2 + O(^1D_2) - 124$ kilocals. (230 $m\mu$)

The observation with single crystals of $KNO_3$, $NH_4NO_3$, $NaNO_3$, etc., in which the $NO'_3$ ions are all oriented parallel to one another, that both the absorption bands are strongly polarised, the ordinary rays being absorbed much more strongly than the extraordinary rays, was interpreted as indicating a corresponding difference between the photo-dissociative activities of the two rays.

We have recently made some experiments on the photo-dissociation of solid inorganic nitrates, particularly with a view to testing the above conclusions. The following are the main results obtained :—

(1) All the nitrates studied, namely those of K, Na, $NH_4$, Sr, Ba, Al, Cd and Pb, showed definite dissociation under the action of light (from a quartz mercury lamp) of wave-lengths shorter than about 250 $m\mu$ (region of the stronger absorption band), as tested by the formation of nitrite. The actual long wave-length limit of the photo-active region of the spectrum was not determined.

(2) The dissociation appears to be confined to a thin surface layer of the crystal, about 20$\mu$ thick. The absence of permanent dissociation in the interior is attributable to the recombination of the products of dissociation.

(3) Experimenting under linearly polarised light (obtained by passing the light from the arc through a quartz double-image prism), with single crystals of $KNO_3$, $NH_4NO_3$ and $NaNO_3$, it was found that the dissociation is much greater when the electric vector of the exciting light is in the plane of the $NO'_3$ ions (ordinary ray) than when it is along the normal to their planes.

(4) $KClO_3$ crystals also show a similar anisotropic photo-dissociation.

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210, Bowbazar Street,
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*February* 25, 1935.

[1] *Curr. Sci.*, 1943, **2**, 476; *Proc. Ind. Acad. Sc.*, 1934, **1**, 242.

## Absorption Spectra of Sulphur-Chlorides and -Oxychlorides in the Vapour State.

IN continuation of previous work already reported,[1] it was found necessary to study the absorption spectra of the series of compounds— $SCl_2$, $S_2Cl_2$, $SOCl_2$ and $SO_2Cl_2$. This work is now complete and we present a summary of the results obtained.

[1] *Curr. Sci.*, 1934, **2**, 433.

| Substance | A | | B | | | C | | | D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *a* | *b* | *a* | *b* | *c* | *a* | *b* | *c* | *a* | *b* | *c* |
| $SCl_2$ | 5825 | 5165 ? | 4550 | 3860 | 3700 | 2770 | 2610 | 2450 | 2350 | 2280 | 2260 |
| $S_2Cl_2$ | | | | | | 2770 | 2580 | 2390 | | | |
| $SOCl_2$ | | | | | | 2900 | 2450 | 2400 | | | |
| $SO_2Cl_2$ | | | | | | | | | 2600—continuous | | |

*a* gives the beginning, *b*, the maximum and *c*, the end of absorption in wavelengths (A. U. in air).

The data for the last three substances are in reasonable agreement with those obtained in their liquid states.[2] It is seen that all the first three compounds show an absorption band in region C. In every case the band is very strong. The maximum of the band is not constant but shows definite shift from compound to compound. These and other considerations rule out the apparent possibility of the band being due to a common impurity. On the other hand they indicate that this absorption is to be connected with the common link, *viz.*, the *p-p* linkage between S and Cl, which all these molecules possess. The absorption spectrum of $SCl_2$ is analogous to that of $OCl_2$.[3] The slight maximum in the region A at 5165 is doubtful and may after all be fortuitous, due to reflection losses in the intensity of the continuous beam. If this is so, region A is just a continuation of the absorption in region B brought about by increase in pressure.

Very often absorption bands due to $SO_2$ present themselves in the spectra of all of these molecules but they can be avoided with due precautions. The general appearance of these bands on the plates is not always the same and varies with different pressures of the vapours of the accompanying molecules. Actual measurement, however, proves that these bands are due to $SO_2$. In particular the band system referred to in our previous communication is now definitely traced by us to $SO_2$. Details will be published shortly.

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Aligarh,
*March* 13, 1935.

² *Zeit fur Physikalische Chemie* (B), 1931, **14**, 219.
³ *Ibid.*, 1931, **15**, 127.

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## On the Ratio of the Temperature Coefficients of Surface Tension and Density.

"MEASUREMENTS have shown that . . . .there is marked parallelism between the temperature coefficient of surface tension . . . .and the coefficient of expansion. The greater the latter, the greater also is the decrease in surface tension per degree, and the ratio

$$\frac{\text{temperature coefficient (of surface tension)}}{\text{coefficient of expansion}}$$

is approximately the same—between 2 and 3—for a very large number of liquids."[1] No formal proof of this observation appears to have been put forward so far. A simple proof based on Laplace's theory of Capillarity is therefore given below.

Laplace assumes that the range of molecular forces is the same for all bodies and that at equal distances the force is proportional to the density of the substance, thus implying that the function $\psi(z)$ is the same for all bodies.[2] This hypothesis, though leading to results incompatible with experiments on interfacial tension, can however be assumed to hold for the same liquid at different temperatures. From Laplace's theory we obtain for the surface tension, T, of a liquid that

$$\mathrm{T} = \tfrac{1}{2}\sigma^2 \int_0^\infty z\psi(z)\,dz \quad \ldots \quad \ldots \quad (a)$$

where $\sigma$ is the density of the liquid. Assuming, by our hypothesis, that $\int_0^\infty z\psi(z)dz$ does not vary with temperature, $\theta$, we get

$$\frac{d\mathrm{T}}{d\theta} = \sigma\frac{d\sigma}{d\theta}\int_0^\infty z\psi(z)\,dz \quad \ldots \quad \ldots \quad (b)$$

Dividing $(b)$ by $(a)$,

$$\frac{\frac{1}{\mathrm{T}}\frac{d\mathrm{T}}{d\theta}}{\frac{1}{\sigma}\frac{d\sigma}{d\theta}} = 2$$

which proves that the required ratio is equal to 2, because $\frac{1}{\sigma}\frac{d\sigma}{d\theta} = -\frac{1}{v}\frac{dv}{d\theta}$, where $v$ is the volume of the liquid. This ratio obtained by Laplace's theory is in close agreement with the experimental observation that it lies between 2 and 3.

The fact that the observed value is always greater than 2 is significant and can be accounted for by assuming that, $\psi(z)$ remaining the same, the range of molecular attraction, $c$, varies with temperature. It follows that

$$\frac{d\mathrm{T}}{d\theta} = \sigma\frac{d\sigma}{d\theta}\int_0^c z\psi(z)\,dz + \tfrac{1}{2}\sigma^2 \int_c^{c+\frac{dc}{d\theta}d\theta} z\psi(z)\,dz$$

¹ *Surface Tension and Surface Energy* by R. S. Willows and E. Hatschek, 1915, p. 7.
² *Vide Properties of Matter* by J. H. Poynting and J. J. Thomson, 1922, p. 179.

because

$$\int_0^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz - \int_0^{c} z\psi(z)dz = \int_c^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz.$$

Hence

$$\frac{\frac{1}{T}\frac{dT}{d\theta}}{\frac{1}{\sigma}\frac{d\sigma}{d\theta}} = 2\left[1+\tfrac{1}{2}\frac{1}{\frac{1}{\sigma}\frac{d\sigma}{d\theta}}\frac{\int_c^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz}{\int_0^{c} z\psi(z)\,dz}\right]$$

$$=2\,(1+\epsilon)$$

where, according to the experimental results, $0 < \epsilon < \frac{1}{2}$. When $\epsilon=0$, it means that

$\int_c^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz = 0$, and hence $\frac{dc}{d\theta}=0$, or there is no variation of $c$ with temperature. But when $\epsilon=\frac{1}{2}$,

$$\frac{\int_c^{c+\frac{dc}{d\theta}d\theta} z\psi(z)dz}{\int_0^{c} z\psi(z)dz} = \frac{1}{\sigma}\frac{d\sigma}{d\theta}.$$

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*February* 26, 1935.

## Anomalous Magnetic Rotation of Uranyl Nitrate.

IN continuation of the work on magneto-optical rotation[1,2] we have made at the suggestion of Prof. S. S. Bhatnagar, some observations on this property in the case of uranium salts. It has been observed that uranyl nitrate shows a negative Faraday effect. The molecular magnetic rotation value is 5·2, assuming that of water to be 1, and it is constant over a wide range of concentration.

All known substances showing a negative Faraday effect with the exception of titanium chloride are paramagnetic (though the converse is not true). The result obtained is of particular significance in view of the fact that this is another substance which in spite of being diamagnetic like titanium chloride shows negative rotation. In the formula of Ladenberg[3] and others[4] for the Faraday effect there exist two terms, one which covers the case of diamagnetic part of the molecule and the other the paramagnetic part. This anomalous effect may be attributed to the influence exercised by the paramagnetic term of these formulæ. Further work is in progress and the results will be communicated shortly.

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## The Optical Rotatory Dispersion of $\alpha$- and $\beta$-Pinenes in the Ultra-Violet.

IN our previous work[5] it was found that the optical rotatory dispersion of $\alpha$-pinene till $= 3000\text{Å}$ could be satisfactorily expressed by a single term Drude's equation of the form $[\alpha] = \frac{k}{\lambda^2 - \lambda_0^2}$ the value of the characteristic frequency $\lambda_0$ being $1900\text{Å}$. This value is in satisfactory agreement with absorption spectrum measurements of $\alpha$-pinene in the vapour state.[6] Our measurements on the rotatory dispersion of $\beta$-pinene till $\lambda = 2784\text{Å}$, which will be published shortly, also indicate the absence of any maximum on the positive side of its rotatory dispersion curve. These observations are in contradiction with those reported by Servant[7] according to whom both $\alpha$- and $\beta$-pinenes in dilute alcoholic solutions attain maximum values in the region $\lambda = 2800\text{Å}$. Our measurements had been made on the pure liquids without the use of any solvent, but since a solvent effect of such magnitude seemed improbable in these cases we measured the rotatory dispersion in alcoholic solutions at approximately the same concentration as was used by Servant. In both cases our previous observations have been confirmed because no anomaly has been noticed till the limit of

[1] Bhatnagar, Mathur and Jain, *Ind. J. Phys.*, 1930, **4**, 503.

[2] Bhatnagar and Kapur, *J. Ind. Chem. Soc.*, 1934, **9**, 767.

[3] Ladenberg, *Zeit. f. Phys.*, 1927, **46**, 168.

[4] Rosenfeld, *Zeit. f. Phys.*, 1930. **57**, 835.

[5] *J. A. C. S.*, 1935, **57**, 334.

[6] Stark, Steubing, Einklaar and Lipp, *Jahrb. Radio activietat*, 1913, **10**, 139.

[7] Servant, *Compt. Rend.*, 1932, **194**, 368.

transmission $\lambda$ = about 2600Å. The absorption of $\beta$-pinene which had not previously been measured was found by a Hilger's "Spekker" spectrophotometer to be negligible till $\lambda$ = 2350Å. Moreover, if it is postulated that the anomalous rotatory dispersion of $\beta$-pinene in the visible spectrum is a superposition effect of two rotations of opposite sign and unequal dispersion, it will be very difficult to explain the second anomaly at $\lambda$ = 2800Å in the absence of an absorption band in that region. These observations coupled with the fact that the specific rotations, so far as they can be calculated from the data given by Servant in his paper, are considerably below those usually ascribed to $\alpha$- and $\beta$-pinenes in the literature would seem to suggest that the anomaly at $\lambda$ = 2800Å is not characteristic of the pure substances.

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*February* 13, 1935.

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## Pasteur's Principle of Molecular Dissymmetry: The *dextro*- and *lævo*-Camphoric Acids.

ACCORDING to Pasteur's principle of molecular dissymmetry, enantiomorphous molecular configurations must possess the same total energy. They must show similar mechanical stability and therefore have an equal chance of being produced. They must also possess identical scalar properties such as density, viscosity, solubility, refraction, dispersion, and Raman frequencies. But they must differ in those physical properties which are of the directional (vectorial) nature, such as, for example, direction of rotation of the plane of polarisation of polarised light, unsymmetrical distribution of the hemihedral facets in the crystal forms and also in the enantiomorphous distribution of pyro- and piezo-electrical polarity. The magnitude of these vectorial properties is, however, identical for the enantiomorphous forms. These results follow from classical mechanics. On the other hand, according to wave-mechanics,[1] the *dextro*- and *lævo*-form of a compound differ in energy and rotatory power although perhaps only to a very slight extent. The same view was also expressed by Campbell[2] based on rather arbitrary assumptions regarding association in racemates and optically active compounds.

In support of the latter view, A. N. Campbell[3] alleges to have produced evidence that the *d*- and *l*-camphoric acids are not identical in their physical properties. In anticipating the criticism which might be brought forward that his materials were not pure, he has taken elaborate pains in giving a detailed statement of the methods of preparation and purification of the two camphoric acids. But Pasteur's law of molecular dissymmetry is too fundamental to be dismissed by a few isolated observations. It seems impossible that the *d*- and *l*-forms of a compound could be other than an object and its non-superposable exact mirror image, agreeing precisely in every detail of structure and of properties except those of a vectorial nature which differ in sign but otherwise are identical in the numerical magnitude in all cases. Moreover it should be borne in mind that the wave-mechanics of rotatory polarisation is, at present, in a rather unsatisfactory condition.

With the object of testing the validity of Pasteur's law as regards the equality in the numerical value of the rotatory power of the opposite active forms, an extended series of investigations on the rotatory dispersion of the enantiomorphous forms was undertaken in this laboratory since 1926. The results of this work, which have gone to confirm Pasteur's law in an unequivocal manner, have been reported in several communications.[4]

In order to remove the above-mentioned discrepancy in the equality of the value of the rotatory power of *dextro*- and *lævo*-camphoric acids, the writer has re-examined their rotatory dispersions. Particular care was taken in following Campbell's methods of preparation and purification of these two acids for obvious reasons. Whereas Campbell found that the rotatory powers of *lævo*-form were systematically lower than those of the *dextro*- for three wave-lengths

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[1] G. Temple, *Trans. Faraday Soc.*, 1930, **26**, 272.

[2] *Nature*, 1929, **124**, 792.

[3] *J. Amer. Chem. Soc.*, 1931, **53**, 1661.

[4] B. K. Singh and B. Bhaduri, *J. Indian Chem. Soc.*, 1930, **7**, 54, 771; *Trans. Faraday Soc.*, 1930, **26**, 347; B. K. Singh, H. P. Basu-Mallik and B. Bhaduri, *J. Indian Chem. Soc.*, 1931, **8**, 95; B.K. Singh, B. Bhaduri and T. P. Barat, *ibid.*, 1931, **8**, 915.

investigated, it is now found that the rotatory dispersions of *dextro-* and *lævo*-forms of camphoric acid are identical for 10 wavelengths ($\lambda = 4358$ to $6709$). These results are given in Table I from which it can be seen that the values of the rotatory power of *dextro-* and *lævo*-forms are identical within the experimental error. A more detailed account of this work will appear elsewhere.

TABLE I.

*Specific Rotation of* d- *and* l-*Camphoric Acids in Ethyl Alcohol at 35° C.*
(Length of tube—2 dcm.)

| Line | | [α] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Form .. | *dextro* | *lævo* | *dextro* | *lævo* | *dextro* | *lævo* | *dextro* | *lævo* | *dextro* | *lævo* |
| | Conc... g/100 c.c. | 1·2533 | 1·2526 | 3·2467 | 3·2473 | 5·2530 | 5·2500 | 7·2500 | 7·2507 | 9·2500 | 9·2480 |
| Hg 4358 .. | .. | +98·94° | −97·40° | +96·15° | −95·62° | +94·41° | −94·87° | +94·37° | −94·76° | +93·30° | .. |
| Cd 5086 .. | .. | 70·61 | 70·70 | 66·66 | 66·99 | 66·24 | 65·92 | 66·00 | 65·93 | 65·21 | −65·23° |
| Ag 5209 .. | .. | 65·83 | 66·26 | 63·46 | 63·33 | 62·63 | 62·86 | 62·40 | 62·50 | 62·03 | 61·99 |
| Hg 5461 .. | .. | 59·44 | 59·08 | 56·84 | 56·83 | 56·35 | 56·19 | 56·21 | 56·12 | 55·40 | 55·46 |
| Ag 5469 .. | .. | 59·04 | 59·08 | 56·84 | 56·82 | 56·15 | 56·19 | 55·86 | 55·78 | 55·49 | 55·41 |
| Hg 5780 .. | .. | 51·46 | 51·89 | 49·90 | 49·89 | 49·68 | 49·71 | 49·38 | 49·38 | 48·91 | 49·08 |
| Na 5892 .. | .. | 49·87 | 50·30 | 48·07 | 48·20 | 47·79 | 47·80 | 47·44 | 47·38 | 46·95 | 47·02 |
| Li 6104 .. | .. | 45·47 | 44·71 | 44·51 | 44·66 | 43·97 | 44·15 | 43·79 | 43·65 | 43·71 | 43·78 |
| Cd 6438 .. | .. | 41·09 | 41·52 | 39·67 | 39·42 | 39·41 | 39·44 | 39·03 | 39·24 | 39·06 | 38·97 |
| Li 6709 .. | .. | 37·50 | 36·32 | 36·22 | 36·19 | 35·98 | 35·82 | 35·72 | 35·66 | 35·62 | 35·56 |

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*March* 8, 1935.

BAWA KARTAR SINGH.

## The Diamagnetic Susceptibility of Water Polymers.

DETERMINATION of the magnetic susceptibility of water at different temperatures by several workers has established that the temperature co-efficient of susceptibility of water is positive; there is, however, not much numerical agreement between the actual values deduced for this co-efficient. The results of Cabrera and Fahlenbrach[1] seem to indicate that for water between 0°C. and 120°C., the temperature co-efficient is constant and has a value equal to $+1 \cdot 15 \times 10^{-4}$. Assuming the values for the relative abundance of the different polymers in water at various temperatures given by Ramakrishna Rao[2] from Raman spectrum data, we can compute the susceptibilities of $(H_2O)$, $(H_2O)_2$ and $(H_2O)_3$:

$$\chi(H_2O) = 1 \cdot 0744 \chi_{20} = -0 \cdot 7755 \times 10^{-6}$$
$$\chi(H_2O)_2 = 1 \cdot 0006 \chi_{20} = -0 \cdot 7222 \times 10^{-6}$$
$$\chi(H_2O)_3 = 0 \cdot 9716 \chi_{20} = -0 \cdot 7013 \times 10^{-6}$$

A value of $-0 \cdot 7218 \times 10^{-6}$ has been assumed for $\chi_{20}$ from the experimental values of Auer. The above results for the three hydrols have been calculated by assuming the constitution of water at 4°C., 38°C. and 98°C. The calculated susceptibility of water at 0°C. by using these values for mono-, di- and trihydrols is $-0 \cdot 7199 \times 10^{-6}$, while the observed value is $-0 \cdot 7201 \times 10^{-6}$. This is in itself a striking agreement. Using Ramakrishna Rao's data for ice, the computed value for the susceptibility of ice works out to be $-0 \cdot 7080 \times 10^{-6}$. If it is assumed that water vapour consists mainly of monohydrols, its specific susceptibility will be nearly $-0 \cdot 7755 \times 10^{-6}$. But "the vapour density of steam is rather too great for the molecular formula $H_2O$ and much too small for $(H_2O)_2$. It is therefore assumed that steam contains a mixture of $H_2O$ with a few $(H_2O)_2$ molecules, and that the equilibrium condition for water vapour, $(H_2O)_2 \rightleftharpoons 2(H_2O)$, corresponds with 91 per cent. of $H_2O$ molecules in the vicinity of 100°C."[3] Computed

[1] *Zeits. f. Physik*, 1933, **82**, 759-764.

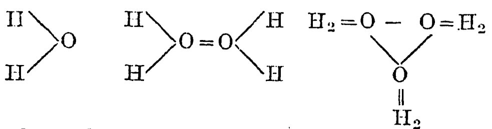
[2] *Proc. Roy. Soc.*, 1934, **145**, 506.

[3] *Modern Inorganic Chemistry* by J. W. Mellor, 1922, 153-154.

on the basis of these assumptions, the susceptibility of steam at 100°C. is $-0\cdot7674 \times 10^{-6}$. The experimental results of Auer[4] show on the other hand that the temperature co-efficient of susceptibility of water is not constant and is itself a function of temperature.[5] A recalculation of the above values is not possible on account of the insufficiency of Auer's data.

The fact that the values of susceptibility of $H_2O$, $(H_2O)_2$ and $(H_2O)_3$ should go on diminishing seems to be in itself significant. It has been shown by Ramachandra Rao and Varadachari[6] that the various hydrates of $H_2SO_4$, like $H_2SO_4 . H_2O$, etc., show a decrease in diamagnetic susceptibility as computed from the additive law. Thus if $SO_4^{--}$ ion is substituted by $O^{--}$ ion in $H_2SO_4$ hydrates, we obtain the water polymers; the decrease in diamagnetic susceptibility resulting from polymerisation in water is seen to be consistent with the observations on the hydrates of sulphuric acid. The percentage deviation from the mixture law is about 10% in $(H_2O)_3$ and about 7% in $(H_2O)_2$; the order of deviation in sulphuric acid hydrates varies from 3 to 4 per cent.

From measurements on the variation of density of water with temperature, Sutherland[7] has concluded that water consists mainly of $(H_2O)_2$ molecules, whereas $(H_2O)_3$ molecules predominate in ice. He has suggested for these molecular aggregates the following graphic formulæ:



monohydrol dihydrol trihydrol

Brühl considers that monohydrol is an unsaturated compound with quadrivalent oxygen. According to the above structural formulæ, it is clear that while the oxygen atom is divalent in monohydrol, it becomes quadrivalent in di- and tri-hydrols.[8] The change in valency is attended by a corresponding change in diamagnetism and we therefore observe that in passing from mono- to di-hydrol the deviation from the additive law is more than 7%. But as we proceed from dihydrol to trihydrol where there is no change of valency, the deviation is less than 3%.

From the values obtained for the mono-, di- and tri-hydrols it is seen that each particular type is by itself diamagnetic. Since diamagnetism shows no variation with temperature and the additive law holds in general for diamagnetic liquid mixtures, we cannot possibly ascribe the temperature variation of susceptibility of water to any other cause except the variation in the relative abundance of the polymers at different temperatures, each polymer being assumed to have a particular value of diamagnetic susceptibility which does not vary with temperature.

I thank Mr. B. Nagesha Rao, Post-graduate student, for checking my calculations.

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*March* 4, 1935.

[4] *Ann. d. Physik*, 1933, **18**, 593-612.

[5] Auer's values of the temperatures co-efficient of susceptibility ($\alpha$) at various temperatures ($\theta$°C) can be satisfactorily represented by the empirical formula: $\alpha \times 10^4 = 0\cdot35 + \frac{16\cdot4}{3\cdot43+\theta}$

[6] *Curr. Sci.*, 1934, **3**, 250.

[7] *Phil. Mag.*, 1900, **50**, 460.

[8] It is assumed by some that the oxygen atom in carbon monoxide is also quadrivalent, *i.e.*, C≡O.

## Free Phenolic Group in Lignin (Evidence from Action of Chlorine Dioxide on Aromatic and Aliphatic Compounds).

THE behaviour of a few organic compounds with one or more free phenolic OH, towards chlorine dioxide (to give simple aliphatic acids) has been utilised by Schmidt and co-workers[1] as well as by Fuchs and Honsig[2] as an argument for assuming the presence of a free phenolic OH group in lignin which behaves in a similar way.

The action of $ClO_2$ on 20 aromatic compounds with free phenolic OH has been tried and it has been found that all of them were readily decomposed. But when the phenolic groups were protected either by methylation or acetylation, the resulting products also reacted with $ClO_2$ but less readily. Acetylated or methylated lignin behaves similarly. Aliphatic OH in the side-chain is also susceptible to the oxidising action of $ClO_2$ and the action is less vigorous when it is methylated or acetylated.

[1] *Ber.*, 1925, **58**, 1394.

[2] *Ber.*, 1926, **59**, 2850.

As lignin contains beyond doubt, more than one methoxy group attached to the benzene ring, it is obvious that the fact that it is acted upon by $ClO_2$ does not in any way prove the existence of aromatic OH in the molecule.

It has also been observed that the only substituent that makes the benzene compounds stable towards $ClO_2$, is the carboxyl; all others are attacked more or less easily. Even toluene and xylenes are oxidised by this reagent. The di-oxymethylene group, however, has been found to be quite resistant towards $ClO_2$.

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*January* 29, 1935.

## Fumeless Digestion of Nitrogen.

ESTIMATION of nitrogen is perhaps the most important item of procedure in modern chemical analysis, over a million determinations being annually carried out by those engaged in scientific research alone. The estimations are usually carried out according to one or the other of the several modifications of the Kjeldahl method,[1] and involve prolonged digestion with concentrated sulphuric acid—an operation which is attended by emission of objectionable acid fumes. Some recent workers[2,3] have suggested that the residue after wet combustion of carbon can be distilled as such for nitrogen, but such a procedure, especially in the case of soils and other biological materials, leads invariably to retention of nitrogen in the digest, and consequently, low and inconsistent estimates being obtained.

A systematic enquiry into the various factors relating to the digestion has shown the following:—(*a*) the conversion of organic nitrogen into ammonia proceeds more rapidly in presence of small amounts of water combined with an oxidising agent (preferably chromic acid) than with concentrated sulphuric acid alone. In the case of soils, a mixture of sulphuric acid and water in the proportion of 2 to 1 yields the best results, the entire digestion being complete in 30 mins. During digestion, the proportion of acid to water has to be maintained constant, so it would be necessary to fit the digesting flask with an air- or water-cooled condenser. (*b*) The digesting mixture requires only a low flame and does not bump, so the long-necked (Kjeldahl) flask generally used for the purpose can be dispensed with. In fact, both the digestion and the distillation can be conducted in the same flask. (*c*) The minute quantities of nitrogen still retained in the digest can be easily released by addition of small amounts of zinc just prior to distillation with alkali. Metallic aluminium or Devarda's alloy can also be used for the purpose, but their action is a little too vigorous, and causes alkali spray to pass over into the distillate. (*d*) In the case of materials containing chlorides, it would be necessary to add a small quantity of mercuric or silver sulphate to the digesting mixture, for, otherwise, free chlorine will be formed and nitrogen will be lost in the elementary form. If the substance (*e.g.*, soil) contains nitrate, the latter should first be extracted with water preferably in presence of a suitable flocculant such as calcium sulphate. The residue is digested in the usual way and the digest, together with the extract containing nitrate, distilled with zinc and alkali, in the manner outlined above.

A simple method embodying the above principles has been developed and applied successfully to the estimation of nitrogen in soils. The procedure is also being extended to other biological materials and to nitrogenous substances in general. Attempts are also being made to combine the above method with that for the estimation of carbon[4] so that both the determinations can be carried out on the same sample.

Y. V. NARAYANAYYA.
V. SUBRAHMANYAN.
Department of Biochemistry,
Indian Institute of Science,
Bangalore,
*March* 12, 1935.

[1] Kjeldahl, *Z. anal. Chem.*, 1883, **22**, 366.

[2] Anderson and Schutte, *J. Biol. Chem.*, 1924, **61**, 57.

[3] Brown, *Ind. Eng. Chem.*, 1927, **19**, 629.

[4] Subrahmanyan, Narayanayya and Bhagvat, *J. Indian Inst. Sci.*, 1934, **17A**, 197.

## The Occurrence of *Choanephora cucurbitarum* (B. & Rav.) Thaxter on *Cassia Tora* Linn.

IN September 1934 our attention was drawn by Prof. B. Sahni to a dead shoot of *Cassia Tora* infected by the white mycelial hyphæ

of *Choanephora cucurbitarum*. Both sporangia and conidial heads of the usual type were noticed. A large number of atypical triangular sporangiospores were found which bore clusters of very fine radiating appendages at the ends. No zygospore stage was found.

This species has been mentioned to occur on the fading flowers of quite unrelated plants such as *Hibiscus*, *Cucumis*, *Gossypium*, *Capsicum* and a number of Cucurbitaceous plants.* ‡

The fungus has been said to be a parasite. But our preliminary observations tend to show that it can also lead a vigorous saprophytic life. An examination of a number of healthy plants of *Cassia Tora* infected with *C. cucurbitarum* did not reveal the existence of the parasite in a number of plants examined out of a great forest of them. But the fallen twigs and leaves where there was plenty of moisture were mostly found infected with the fungus. This fact has raised doubts in our minds whether it is an obligate parasite at all. A single inoculation on the stem and leaves of the vigorous plants did not give any satisfactory results. Inoculation experiments will be repeated in the next rainy season when the weather conditions are favourable.

H. P. CHOWDHURY.
R. S. MATHUR.

Department of Botany,
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*February* 25, 1935.

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## Observations on the Systematic Position of *Ficus Krishnæ* growing at the Royal Botanic Garden, Calcutta.

ONE of the trees of *Ficus Krishnæ* C. de C., growing for more than thirty-two years in the nursery of the Royal Botanic Garden, Calcutta, developed what may be called a bud mutation[1] on one of its branches—about five years ago—as shown in Fig. 1.

The broad flat leaves like the leaves of *Ficus bengalensis* are the mutated leaves. The rest are all cup-shaped normal leaves of *Ficus Krishnæ*.

**Fig. 1.**

Mutated branch of *Ficus Krishnæ*.

Germination experiment from the seeds of *Ficus Krishnæ* shows only about 10 per cent. breeding true, the rest, about 90 per cent., are of the type of *Ficus bengalensis* L. But when *Ficus Krishnæ* is propagated from *gooties* or cuttings of *Ficus Krishnæ* the daughter plant nearly always bears hypoascidi-form leaves of the mother plant. This *Ficus Krishnæ* which has exhibited bud mutation was introduced during the last decade of the nineteenth century in the Royal Botanic Garden from cuttings secured from another plant of *Ficus Krishnæ* growing in a private garden in the neighbourhood of the Calcutta Botanic Gardens. The plant was named by C. de Candolle in 1901 as a separate species. The Indian view is that it is a modified garden variety of *Ficus bengalensis*. It is from this garden that cuttings were sent to C. de Candolle at Geneva and to Kew—sometime in 1900-1901. The plant was successfully grown in the tropical house at the Kew Garden which produced receptacle for the first time in 1905.[2] Prof. Hans Molisch who happened to pay a visit to the Calcutta Botanic Garden

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* H. M. Fitzpatrick, *The Lower Phycomycetes*, 1930, pp. 259, 262.

‡ Dastur, J. F., *Choanephora cucurbitarum* (B. & Rav.) Thaxter on chillies (*Capsicum* spp.). *Ann. Bot.*, 1920, **34**, 399.

[1] Biswas, K., "Bud Mutation," *Nature*, 1932, **130**, 780.

[2] Prain, D., *Curtis' Botanical Magazine*, 1906, **2**, Tab. 8092.

in 1929[3] considers *Ficus Krishnæ* a mutation of *Ficus bengalensis*. Further he remarks that if C. de Candolle would have seen this mutation on this tree (*Ficus Krishnæ*) at the Royal Botanic Garden, Calcutta, he would not have taken it as a separate species. Penzig mentions that some authors consider these beaker-like "Hypoascidien" leaves abnormal forms.[4] Germination of the seeds and floral structures of *Ficus bengalensis* and *Ficus Krishnæ* hardly exhibit any variation between the two.

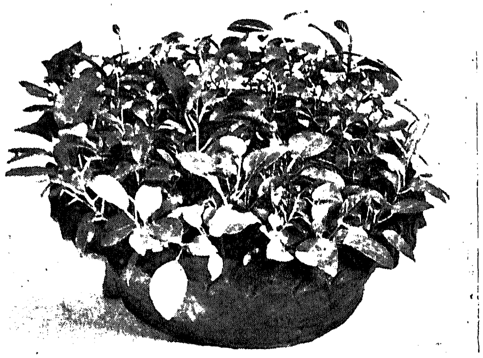

**Fig. 2.**

Seedlings of *Ficus Krishnæ* developing like the seedlings of *Ficus bengalensis*.

The difficulty is, as Sir David Prain notes, that we do not know the history of the parent tree in the neighbourhood of the Royal Botanic Garden—from which the

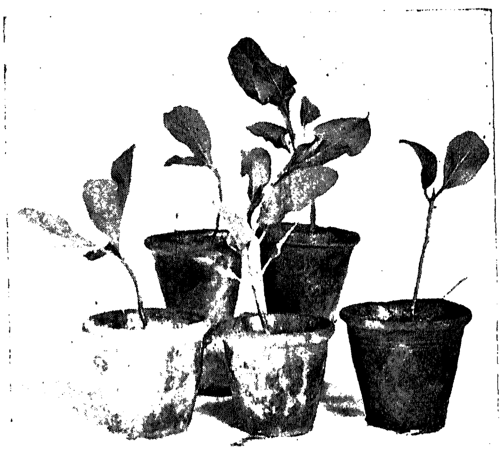

**Fig. 3.**

Young plants of *Ficus Krishnæ* grown from gooties.

[3] Molisch, H., *Als Naturforscher in Indien*, 1930.

[4] Penzig, O., *Pflanzen-teratologie*, 1922, **3**.

plant was cultivated in this garden. This problem of mutation, therefore, may be solved by cytogenetical investigation. Purely cytological characters, as the late Prof. S. R. Kashyap's preliminary examination proved, may not be quite definite to solve the problem of such reversion.[5] *Ficus Krishnæ* belongs to the section *Urostigma*. The writer considers, on the ground stated above, that this *Ficus Krishnæ* is a horticultural variety of *Ficus bengalensis*. The anatomical characters also exhibit normal fusion of tissues leading on to the formation of "Hypoascidien" leaves.

K. BISWAS.

Herbarium,
Royal Botanic Garden,
Calcutta,
*February* 20, 1935.

[5] King, G., *Ann. of the R. B. Garden, Calcutta*, 1888, **1**.

## The Morphology of the Bulbils of *Globba* sp.

THE morphological nature of the bulbils of *Globba* has been investigated by W. D. van Leeuwen and others. It is generally believed that among the bulbils of *Globba* certain species are found in which storage of food material takes place in root-tubers while in some cases there are storage rhizomes and the roots are not tuberous. The results of investigations on the morphology of the bulbils of *Globba* sp. carried out by me in this laboratory, however, strongly suggest that these appear to be highly metamorphosed fruit bodies. The following points observed support the above view:—

(1) Occurrence and position in the inflorescence. (2) Relative position of the bud and the storage tissue (*cf.* similar monocot seed). (3) Presence of coatings round the storage tissue. (4) External appearance similar to a normally developed ovary (fruit). (5) Attainment of more or less the size by all, when mature. (6) Growth while attached to the inflorescence in the manner of a viviparous fruit.

The results of detailed investigations will be communicated in a separate paper.

S. GHOSE.

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*February* 15, 1935.

## Specificity of Parasitism by *Eublemma amabilis*.

MAHDIHASSAN[1] states that Imms and Chatterjee[2] suspected *E. tachardiæ* to be a beneficial insect and that he himself definitely proved it to be a parasite of *Eublemma amabilis* caterpillars.

The Indian Lac Research Institute began its work on the lac insect and on its parasites and predators in 1926 and during the last eight years many miles of lac encrustation and many thousands of *E. amabilis* larvæ have been examined in the Entomological Department. Our investigations have proved *E. tachardiæ* to be a parasite of the lac insect *L. lacca* and in no instance has this species been found to be parasitic on *E. amabilis*. This view was first put forward by Gupta, Negi and Misra[3] in 1929 who also record *Machærota* sp. as an alternative host; in the *Institute Annual Report* for 1928-29 *E. tachardiæ* is noted as a hyperparasite of *Bracon tachardiæ* which is further confirmed by Glover[4,5] who states that *E. tachardiæ* is also parasitic on *Machærota planitiæ* and hyperparasitic on *Apanteles tachardiæ*. Gupta and Negi[6] reconfirm these observations and add a further alternative host in *Holcocera pulverea*, a lac predator (Misra and Gupta[7] in their paper on this predator quote a single instance only of parasitism of *H. pulverea* by *E. tachardiæ*) and record it also as a hyperparasite of the two lac parasites *Tachardiæphagus tachardiæ* and *Erencyrtus dewitzi*.

In addition, Misra, Negi and Gupta[8] in their paper on *E. amabilis* make no reference to *E. tachardiæ* as a parasite of this predator.

*E. tachardiæ* as previously stated is hyperparasitic on *Microbracon tachardiæ*, a parasite of *Eublemma amabilis* and we have frequently bred *E. tachardiæ* on *Microbracon tachardiæ* in the laboratory. In this connection, Gupta and Negi[6] state "The *Chalcid B. annulicaudis* is primarily an endoparasite of the lac insect, and an ectoparasite of the full-fed larvæ, pre-pupæ and early pupæ of *B. tachardiæ* a parasite (of) *E. amabilis* larva. The *Chalcid* oviposits on the stages of *B. tachardiæ* only if covered with a cocoon."

Gernet's finding of E. *amabilis* and *E. tachardiæ* closely associated in dried stick lac in 1863 in Russia, which Mahdihassan quotes in his letter as an indirect support for his theory that *E. tachardiæ* is a parasite of *E. amabilis*, is of course equally in accordance with their true relationship, and one wonders whether Mahdihassan may not have been misled into mistaking a hyperparasite for a parasite.

The "glaring statement" made by Glover[4,5] and repeated by Glover[9] of "having found it (*E. tachardiæ*) inimical to lac itself" is in fact no more than the truth.

Mahdihassan, to use his own words, after a thorough survey of the *Coccid* fauna of Bangalore, states: "There is no danger to the lac insect in its common enemies having alternative hosts....for such an enquiry.... gave at every step a negative result ....and (led) to specificity of parasiticism" and he criticises Glover[5] whom he quotes, "Several (lac parasites) are suspected of parasitising also insects other than lac .... the alternative host forms a convenient breeding ground for the parasites." Further research has however fully justified Glover's statement, the following being concrete examples:—

*Eupelmus tachardiæ*, parasitic on *Laccifer lacca*, alternative host *Machærota planitiæ*—Gupta, Negi, Misra[3] and Glover[4].

*Tetrastichus purpureus*, parasitic on *Laccifer lacca*, alternative host *Aspidiotus orientalis*—Glover.[10]

| | |
|---|---|
| *Marietta javensis* Syn. (*Microterys hautfeulli* Mahd ?) | Parasitic on *Laccifer lacca*, alternative host *Aspidiotus orientalis* —Glover.[9] |

The generic name *Lakshadia* used by Mahdihassan is not recognised by Chamberlin[11] an authority on the *Lacciferidæ* or lac insects, and should be abandoned in keeping with the rules of zoological nomenclature;

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[1] Mahdihassan, *Curr. Sci.*, 1934, **3**, 260.

[2] Imms, A. D., Chatterjee, N. C., *Ind. For. Mem.*, 1915, **3**, 1.

[3] Gupta, S. N., Negi, P. S., and Misra, M. P., *Proc. Ind. Sci. Cong.*, 1929.

[4] Glover, P. M.. *Bull. Ent. Res.*, 1930, No. 21, 3.

[5] Glover, P. M., *A Practical Manual of Lac Cultivation*, Calcutta, 1931.

[6] Gupta, S. N., and Negi, P. S., *Proc. Ind. Sci. Cong.*, 1933.

[7] Misra, M. P., and Gupta, S. N., *Ind. J. Agric. Sci.*, 1934, **4**.

[8] Misra, M. P., Negi, P. S., and Gupta, S. N., *J. Bombay Nat. Hist. Soc.* 1930.

[9] Glover, M. P., *Ind. Lac. Res. Inst. Bull.*, 1934, No. 21.

[10] Glover, P. M., *Ind. Lac Res. Inst. Bull.*, 1933, No. 16.

[11] Chamberlin, J. C., *Bull. Ent. Res.*, 1925, No. 16.

of *Laccifer mysorensis* (Mahdihassan's *Lakshadia mysorensis*) he says, "It seems possible that this form is racially or sub-specifically distinct from *lacca*."

The latter part of Mahdihassan's letter indicates that *E. amabilis* is monophagus or at least confined to species of the Genus *Laccifer*. The behaviour of females of monophagus insects of ovipositing only on the host on which the progeny can feed is too well known to merit his further comment.

In examining lac samples at this Institute, not a single one has been found free from that attack of *E. amabilis*, the degree of infestation has of course varied considerably. The liability of lac to attack by this predator does not, according to our experience, depend exclusively on the host plant, being influenced by a considerable range of factors, and it is unlikely that use of a "catch" crop, as Mahdihassan suggests, would be of any great value as a control, at any rate in the important lac growing areas.

P. M. GLOVER.
P. S. NEGI.
Indian Lac Research Institute,
Namkum, Ranchi, Bihar and Orissa,
*January*, 1935.

## Enteropneusta from Krusadai Island.

IN his note on "Enteropneusta from Krusadai Island,"[1] Prof. C. R. Narayana Rao stated:—"S. G. M. Ramanujam has also taken specimens from the same area but it is rather surprising that our collections do not include any of the specimens represented in Dr. Ramanujam's, which does not possess a single form contained in our material. But still both parties were investigating the same area and this rather curious phenomenon of distribution is worth carefully looking into." Since this note was published, I have had an opportunity of visiting the area again and was able to obtain the forms contained in Prof. Narayana Rao's material. My first collection of Balanoglossids was made in September 1930 in the sandy areas of the Porites' and Watchman's Bay. We concentrated at that time on the Northern shores of the Island, facing Mandapam. It was then that the specimens were obtained which Prof. Narayana Rao has kindly identified as *Ptychodera minuta* and *Glandiceps hacksi* and which are not represented in his collections from the Krusadai Island. These forms were by no means abundant and obtained while searching for polychæte worms.

In our visit last October-November, we worked on the Southern side of the Island between the Sandy and Bushy points and were agreeably surprised to find large forms of Balanoglossids which were species of *Chlamydothorax*. Presumably all of Prof. Narayana Rao's material came from this region. A whole bed of sand in this area consisted practically of Balanoglossids and, as it were, one could collect half a dozen specimens in a square foot of area, so that this area has been designated the Balanoglossus Area.

Last January, another party from the Department collected in the same area and the forms, though of the same species, were much bigger and better developed, indicating growth.

It is then evident that the forms on the two shores of the Island differ and, as Prof. Narayana Rao has remarked "this rather curious phenomenon of distribution is worth looking into". Much to our regret, it was not possible owing to high tides to collect on the northern shores during our recent visits to the Island.

S. G. MANAVALA RAMANUJAM.
Department of Zoology,
Presidency College,
Madras,
*March*, 1935.

[1] *Curr. Sci.*, August 1934, **3**, 70.

## Occurrence of the Pelagic Gastropod *Recluzia* (Petit) in Madras.

OF the pelagic Gastropoda *Ianthinide* show that peculiar adaptation of secreting a float which keeps the animal to the surface. In *Ianthina*, the shell is violet-coloured and delicate, and the float is clean-looking.

In a recent trip to Pulicat about 30 miles from Madras, on the 18th and 19th January last, three specimens of a Gastropod were obtained which showed a float of the same nature as that of *Ianthina* and to which on the under side crowded rows of eggs were attached. The shell is rather brownish, dark and light shades alternating, comparatively thick and the spire rather high, as compared to that of *Ianthina*. The float is somewhat muddy-looking. This latter appearance may partly be due to the rows of brown eggs attached on the under surface. The specimens tally with the figure and general description of *Recluzia* given in

Cheno's *Manual de Conchyliologie*, Tome I, p. 119, 1859.

The occurrence of *Recluzia*, so far as I am able to ascertain, has not been recorded hitherto on Indian shores.

A specimen was also obtained from the Madras shore, opposite the Fort, on 7th February by a post-graduate student of this Department.

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*February* 28, 1935.

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## The Age of the Deccan Traps.

I HAVE read with considerable interest the paper "The Deccan Traps: Are they Cretaceous or Tertiary", by Dr. B. Sahni in your journal.[1] I would have written before had I seen this valuable contribution earlier, but I have only recently returned from leave.

The occurrence of plant remains and a lacustrine fauna has long been known by the fossils found in the inter-trappean beds of the Deccan trap lavas of Nagpur and Chhindwara, which are considered as among the lowest flows of the volcanic series. There is thus no question that Dr. Sahni's remarks apply to the believed basal beds of the Deccan Traps.

The official opinion in regard to the Deccan Volcanic series is that three main sub-divisions have been recognised, which, arranged in order of their outpouring, may be placed in the stratigraphical succession as follows:

III. Upper Traps of Bombay and Western India;
II. Middle Traps of Malwa and Central India; and
I. Lower Traps of Nagpur and Central Provinces.

This arrangement is based on general conclusions and not on continuous geological mapping from say Nagpur to Bombay, where the geologist could walk on these basaltic lavas all the way. Consequently, these problems of the age of an entire volcanic series cannot be settled by the evidence of the fossils of an assumed horizon.

The strata immediately below the Deccan traps in the Nerbada valley and Central India are the Bagh Beds, which are unquestionably regarded as of middle to upper Cretaceous age. The Bagh Beds, a marine series, have been considered as the equivalent of the fresh-water infra-trappeans of the Central Provinces known as the Lametas. These rocks have not been clearly traced from one to the other by actual mapping.[2]

The age of the Lametas is thus in dispute,[3] but in this connection the infra-trappean beds (Lametas) of the Rajahmundry area, about Dudkur and Pangadi, are of considerable interest.[4] These beds are regarded as an estuarine deposit, the fauna of which is curiously Tertiary in assemblage, and considered somewhat younger (newer) than the Bagh Beds but still of Cretaceous age.

These infra-trappeans of the Godavari near Rajahmundry are of course related to the Deccan traps of that region. In these lavas, near Kateru, there are inter-trappean fossiliferous beds with a fresh- to brackish-water fauna, which appears to have no Tertiary affinities, and has relationships with the Upper Cretaceous rocks of South India. So far as I know this paradoxical evidence has not been re-examined by a competent palæontologist.

From the fact that palm fossil wood occurs in the inter-trappeans north of the Nerbada among the so-called Malwa Traps of Saugor[5] it is evident that the broad sub-divisions of the Deccan Trap series recognised above must be regarded as simply tentative. And I would say that the official opinion that the Deccan Trap series is entirely of Cretaceous age is largely out of date and not the view of those officers who are most familiar with these lavas, but a revised official opinion cannot be published without sufficient evidence.

It will be remembered that no less an authority than Dr. W. T. Blanford, after a personal investigation wrote[6] as follows, *in italics*:—

> "....that the lowest traps appear to differ less in age from the middle cretaceous beds of Bagh than the highest traps do from the lower eocene formations of Surat."

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[1] *Curr. Sci.*, 1934, **3**, 134-136.

[2] *Mem. Geol. Surv. India*, 1860, **2**, 196.

[3] *Ibid.*, 1926, **51**, 102-103.

[4] *Man. Geology of India*, Part 1, 1879, 317.

[5] H. H. Spry, *Journ. As. Soc. Bengal*, 1833, **2**, 639; and W. T. Nicolls, *Journ. Bom. As. Soc.*, 1857, **5**, 614.

[6] *Mem. Geol. Surv. India*, 1867, **6**, 159.

and that Dr. T. Oldham[7] thought that the evidence then available did not support that generalisation, and favoured an Eocene age.

Dr. Sahni has drawn attention to these points, and I do not but accept Dr. Sahni's identifications and conclusions regarding the specimens and inter-trappean beds with which he has specifically dealt, but it must not be assumed that the whole question of the *age* of the Deccan Trap series is now settled because the evidence from Chhindwara points to a Tertiary age.

Dr. W. T. Blanford possessed an uncanny judgment and unrivalled knowledge of the Indian fossiliferous formations as a whole, in addition to a personal study of the Deccan Traps of Western India. His conclusions point to the volcanic period as possibly straddling the close of the Cretaceous and the beginning of the Tertiary era. This, I think, is the opinion of those of my colleagues with whom at odd times I have discussed this problem.

Mr. R. D. Oldham's cautious remarks in the 2nd edition of the Manual[8] indicate Dr. Blanford's respect, and all subsequent work on the stratigraphy of the Indian formations has shown the accuracy of Dr. Blanford's work and judgment. We would not alter any of his opinions now unless it was proved necessary by the evidence of exhaustive field work. He did not say that the Deccan Trap series as a whole were of Cretaceous age, nor do the traps of the Bagh area necessarily involve those of Nagpur. Dr. Blanford may have believed that the Nagpur traps came between the Bagh beds and the traps above the Bagh infra-trappeans of the Nerbada valley, but this is not definitely stated, and the evidence of the inter-trappeans of Kateru may have been used.

To give some idea of the nature of the problem involved I would like to say that I have traced the Deccan Trap lavas (and dykes and sills) across the head-waters of the Son River, from Amarkantak and South Rewa into Korea and Sirguja and on, to the Ranchi and Palamau districts. From Netarhat in the last-named area one may practically overlook the coalfield of Karanpura in the Damodar valley. This can be definitely done so from the most easterly of the laterite capped plateau of the Ranchi district north of Lohardaga.

[7] *Rec. Geol. Surv. India*, 1871, **4**, 77.

[8] *Geology of India*, 1893, 282-83.

In the Karanpura coalfield there are dolerite dykes the material of which is petrologically identical with the dolerite sills and dykes of the Deccan Trap in Rewa and Sirguja. The distance from the Karanpura coal-field to the most easterly Deccan Trap outlier, at Netarhat, is *under* 50 miles, while it is more than three times this distance to the nearest occurrence of undoubted Rajmahal trap which is established as of Jurassic age. It is *more* than 50 miles from the Rajmahal traps to the Giridih coalfield where dolerite dykes identical with those in the Karanpura and intervening—Jharia and Raniganj—coalfields occur. Because of proximity the dolerite dykes in the Giridih field were regarded as of Jurassic age, and this geological age was also given to the dykes in the Raniganj and Jharia fields. Had the earliest work been done from the west it is certain that a Deccan trap age would have been offered for all these intrusions in the coalfields. The dykes in the Karanpura field are exactly the same, even to the association of peridotites, as those in the Jharia and Raniganj and Giridih coalfields. The petrological similarity of the Deccan and Rajmahal traps has long been known.

Again it had been early suggested that the so-called Sylhet trap of Assam, which is definitely not only pre-Eocene but overlaid by fossiliferous Upper Cretaceous strata might be the equivalent of the Rajmahal trap. I had thought[9] from specimens in our collection, that the Sylhet trap was different, petrologically, from the Rajmahal trap. However, during the last three years I have personally examined the Sylhet trap in the Khasi and Garo Hills and found these rocks, chiefly dolerite dykes, to be indistinguishable from the dykes in the Damodar Valley coalfields both in hand specimens and under the microscope. Here then is a pretty problem regarding the relationship of the Jurassic Rajmahal traps to the most easterly Deccan traps in Bihar.

I doubt if any of my colleagues who are fully acquainted with the subject of the Deccan traps hold the view that our official publications, quoted by Dr. Sahni, give, *i.e.*, that these volcanic eruptions were entirely confined to the Upper Cretaceous. The opinion is still that of Dr. Blanford in broad outline—that these Deccan lavas were poured out in the epoch which covers the close of

[9] *Mem. Geol. Surv. India*, 1930, **56**, 114.

the Mesozoic and the early beginnings of the Cainozoic eras. To me the nature of the eruptions has always appeared complex but I have felt that in a general way the earliest outburst of activity was in north-eastern India, and that, broadly speaking, the successive series of eruptions occurred in newer areas each further west than the previous until the volcanic period finally died out in north-western India.[10]

I am glad of the opportunity Dr. Sahni has given me to express the opinions I have as they represent the views of those of my colleagues with whom I have been able to discuss his paper. He knows me well enough to understand that I appreciate the importance of his palæo-botanical work and that I do not feel qualified to discuss the value of his determinations of plant fossils as absolute indicators of a geological horizon. Although I worked in the Chhindwara district for many years I did not include Mohgaon Kalan (22° 1′ : 79° 2′), 18 miles east of Chhindwara and 4 miles south-east of Jhilmili railway station, in my mapping, but it is clearly in a trap area among the lower flows of the Chhindwara district. The question now arises whether these are really among the lowest lavas of the Deccan Trap series.

In conclusion I would like to say that not until we come to the Bagh beds of the Nerbada have any signs of marine conditions been discovered for the Cretaceous Sea, while the Nummulitics of Surat show the presence of the sea in Eocene times. It follows simply from this that an estuary opening westwards probably did exist during those geological epochs, but it is difficult to believe in the persistence of this estuary in the intervening period (epoch) as it was almost certainly filled up by the Deccan trap lavas. These, accepted as of sub-ærial origin, are known to be at least 2,000 feet thick in Kathiawar. We are convinced that the break-up of the Gondwana continent, by a great series of subsidences of the land westward under the waters of the Arabian Sea, did not become fully effective, so far as the west coast of India is concerned, until after the close of the Deccan volcanic eruptions. The main features of the present configuration of the west coast of India appear not to have become fully established until the late Eocene period, although faulting continued long afterwards in Miocene times and later. I have drawn a series of maps showing the distribution of land and sea at various periods in the Mesozoic and Cainozoic eras, which will shortly be published in my memoir on "The Tertiary Coalfields of India" (now in preparation).

CYRIL S. FOX.

Geological Survey of India,
27, Chowringhee, Calcutta,
*February* 7, 1935.

10 *Rec. Geol. Surv. India*, 1925, **58**, 90.

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I AM thankful for an opportunity of reading Dr. Fox's valued comments on my note suggesting a Tertiary age for the Deccan Traps.

It is satisfactory to learn that the official view as expressed in the Geological Survey's publications is not shared by those of Dr. Fox's colleagues who are most familiar with these lavas. Assuming, as Dr. Fox agrees, that the flows of Nagpur-Chhindwara are the oldest in the series, the palæobotanical evidence from that area distinctly supports the view that the date of the earliest eruptions was later than the Uppermost Cretaceous. In this connection, the evidence from Mohgaon Kalan and Sausar Tahsil alone is of considerable significance, because the *Nipadites* came from the former locality of which the flora is dominated by palms, while the *Azolla* abounds in the cherts of the Sausar region. Without further evidence, it would be difficult to say how much younger the Bombay Traps are than those of the Central Provinces and of Malwa and Central India. The mere fact of the occurrence of fossil palm wood in the inter-trappeans of Saugor (Central India) can be of no help to us here. The indications are that the whole period represented by the traps from Nagpur as far as the west coast was comprised within the lower Tertiary and probably within the Eocene. But I must not trespass upon ground which is not familiar to me: I am not aware of any palæobotanical facts in support of this view.

However, the main point is that if the testimony of the plant-remains is to be relied upon we must agree that the Tertiary era had already dawned when the first lavas of the Deccan were poured out. We shall no doubt soon be in a position to check this conclusion independently because precise methods are now available for calculating

the geological ages of igneous rocks from the evidence of their radioactive minerals.

B. SAHNI.

Department of Botany,
University of Lucknow,
*February 15, 1935.*

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## A Note on the Origin of the Kaldurga Conglomerates, Mysore.

IT is well known that the question of the probable mode of origin of the Kaldurga (13° 39′ : 75° 51′) conglomerates has had an interesting history. Till the year 1908 these and other similar conglomerates elsewhere in Mysore were described as sedimentary. Later, Dr. W. F. Smeeth examined the Mallappanhalli and Aimangala conglomerates of the Chitaldrug Schist belt during the field season 1909-1910, and pointed out certain evidences in favour of their being considered as autoclastic in character and *not* of the nature of true sedimentary conglomerates. This idea was soon extended to all the other conglomerates of Mysore; every one of these was shown to fit in with the "autoclastic" theory and the original suggestion of these being true sedimentary conglomerates came to be completely abandoned.

In the course of a recent examination of these conglomeratic rocks near Kaldurga—the classical area where the autoclastic nature of the conglomerates was considered to have been definitely established by Mr. P. Sampat Iyengar—I have made two observations which I consider interesting and important.

(1) The conglomerate is often crowded with a large number of pebbles of a varied character. For instance, I collected a specimen from the south of Kaldurga, about 6″ × 9″ in size, containing more than twenty-five pebbles composed of such widely different rock types as gneiss, granite, quartzites (two types), vesicular spilite and altered dolerite. From other specimens in the locality, I obtained pebbles of banded quartzite, limestone, vein quartz, etc. Several of the rock masses from which these pebbles must have been derived are now far away from the area where these specimens are found. The most interesting pebble seen in one of the exposures of this conglomerate, is of the "Galipuje felsite"; this pebble must obviously have been derived from the *in situ* occurrence of this rock near Galipuje, about sixteen miles away from the spot where the pebble was noticed in the conglomerate.

(2) In another part of the conglomerates, near Aladhalli (about four miles south of Kaldurga), I find the conglomerate showing a striking gritty character; and what is more interesting, some of these grits show a distinct graded bedding. The rock here has layers about a foot in thickness, one overlying the other. Each layer starts with a more or less coarse pebbly character and gradually becomes finer and finer, till the next layer again starts abruptly with coarse pebbles, grading on into fine. (*Vide* Fig. 1.)

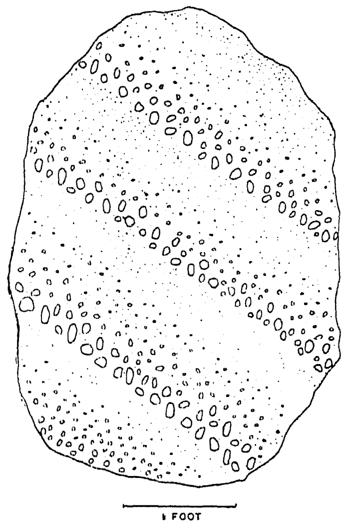


**Fig. 1.**

Boulder of conglomerate showing graded bedding.

It is difficult to understand how these two facts of observation could be reasonably explained on the basis of the "autoclastic" theory. On the other hand, they appear to me to be distinctly suggestive of an original sedimentary character for these conglomerates. A more detailed investigation of these rocks is under progress and when this is complete, it may be possible to show that the conglomerates dealt with here are really of sedimentary origin though it is true that subsequent crushing and shearing have tended to obscure their original nature.

CHARLES S. PICHAMUTHU.

Department of Geology,
University of Mysore,
*February 12, 1935.*

## A Microchemical Test for Protein Grains in Plant Cells.

By R. H. Dastur and U. K. Kanitkar,
*Botany Department, Royal Institute of Science, Bombay.*

PROTEINS and their products of decomposition yield a variety of colour reactions each characteristic of a particular group of nucleus. These reactions are not directly applicable for their detection when they occur with other interfering substances as they do in plant cells. The cells of leaves, in particular, offer exceptional difficulties, on account of the presence of the green chlorophyll.

We have developed in our laboratories a convenient and reliable michrochemical method which has been found useful in the study of the synthesis of proteins in the leaves of *Abutilon asiaticum* G.Don., and those of *Ricinus communis* L., under exposure to artificial light.

Folin and Wu's[1] β-naphthoquinone-sulphonic acid colour reaction found applicable for the detection of amino acids in blood was extended to plant cells. Sections of tissue under examination are first treated with alkaline β-naphthoquinone (2 c.c. of 0·5 per cent. aqueous solution of the sodium salt of β-naphthoquinone-sulphonic acid + 1 c.c. of 1 per cent. sodium carbonate and 4 drops of 1 per cent. phenolphthalein) for 30 hrs., then transferred to a mixture of acetic acid (50 per cent.) and sodium acetate (5 per cent.), washed for half minute, treated with a 4 per cent. solution of sodium thiosulphate for 5 minutes, washed, dehydrated and finally mounted in glycerine. On examination under the microscope, the presence of amino acids in the leaf, petioles, cotyledons and hypocotyledonous regions of the seedlings and radicles of the beans and gram is revealed. The method, however, suffers from the disadvantage that it is not specific to proteins, since their degradation products also respond to the test.

A reagent obtained by dissolving 0·2 gm. of orthoquinone in 20 c.c. of 95 per cent. ethyl alcohol and mixed with 1 c.c. of 1 per cent. sodium carbonate solution has proved satisfactory as a specific reagent for proteins. Preliminary trials with rice and wheat grains definitely indicate that while the starch and other non-proteinous matter are not stained, the protein grains in the aleurone layer take up a deep colour. It should be mentioned however that the reagent stains the protoplasm but the protein grains are more deeply stained and are therefore distinguishable from the surrounding protoplasm.

In the case of leaves, the interfering chlorophyll is first removed by treatment with hot boiling 20 per cent. alcohol for 15–30 mins. The leaf is then kept in the orthoquinone reagent for 2 days and after washing with alcohol sections are cut, mounted and examined under the microscope. The deeply stained protein grains are easily distinguishable. This procedure has proved invaluable in the study of the size and number of protein grains in cells.

[1] *J. Biol. Chem.*, 1922, **51**, 377.

## The Public Health of India.

THE Report of the Public Health Commissioner for 1931 which has now become public is a valuable document dealing with Vital Statistics, Antimalarial and Anti-tuberculosis campaigns, Leprosy surveys, etc., and several other topics of public health interest. The infantile death rate was high—more than double that in Germany, England & Wales and South Africa. Tuberculosis was on the increase and the anti-tuberculosis campaign had not proceeded very far. The Leprosy Survey clearly indicated that the disease was much more prevalent than was formerly supposed.

Major-General J. D. Graham, Public Health Commissioner, recommends the formation of a Ministry of Health, an organisation which shall be competent to frame and conduct a Public Health Policy for the country as a whole.

out of the fruit, the latter being still on the parent plant.

*Coccinia indica* is a member of the family *Cucurbitaceæ* and it is not surprising at all to find viviparous germination of seeds in it, but what is most striking is that the shoot has managed to pierce through the fruit while the latter being still on the parent plant. The fruits are quite intact and there is not the slightest sign of any disintegration.

Referring to the mode of germination in *Cucurbitaceæ*, we find that the cotyledons come above ground as the first leaves of the plant. In our case it seems that one of the two cotyledons is transformed into a leaf and the other into a tendril. As the tendrils in the *Cucurbitaceæ* have always been a subject of great controversy the present finding of ours might serve as a further proof in favour of one of the theories advanced regarding the nature of the tendrils in this family.

The theories in brief are the following:—

(1) A tendril in the family *Cucurbitaceæ* is one of the bracteoles of a flower which is an axillary shoot of a foliage-leaf. The tendril (bracteole) has been pushed of its original position on the primary shoot (or flower) to its present position by the side of the foliage-leaf (Braun's suggestion which nas been adopted by Eichler and others).

(2) Twining part of a tendril is a leaf-structure; lower stiff portion is a stem-structure (Muller).

(3) Modified stipules, *viz.*, in *Kedrostis spinosa* (Engler).

(4) "The developmental history of the individual tendril shows in many cases clearly the direct transformation of the primordium of the foliage leaf into a tendril, the leaf-lamina being rudimentary (Goebel).

Anatomical studies are in progress, and the final conclusion as to the nature of the tendrils in this particular case must be reserved till their completion.

LITERATURE.

Goebel, K., *Organography of Plants*, Part II.

Guppy, H. B., *Studies in Seeds and Fruits.*

Muller, E. G. O.. *Pflanzenfamilien.*

Rendle, A. B., *Classification of Flowering Plants*, Vol II.

Thiselton-dyer, Sir W. T., *Annals of Botony*, Vol. XVI, pp. 149-153.

Willis, J. C., *Dictionary of the Flowering Plants and Ferns.*

## Cause of Formation of a Heterocœlous Vertebra in Bird.

By Himadri Kumar Mookerjee,
*Zoology Department, Calcutta University.*

IN a recent communication in *Nature*[1] I have shown how procœlous, ophisthocœlous and amphicœlous vertebræ are formed. In each of these forms of vertebra the formation of the notochord is the starting point. Soon after the formation of the notochord and its peripheral sheaths the skeletogenous cells aggregate round them forming an outermost jacket as perichordal tube. The vertebral portions of the perichordal tube soon become cartilaginous while the intervertebral portions of it remain membraneous or procartilaginous for a considerable time. I have shown for the first time that through these intervertebral zones of perichordal tube, the migratory connective tissue cells enter.[2,3]

A strand of migratory connective tissue cells normally enters through the intervertebral zones of the perichordal tube, keeping its direction at right angles to the notochord. It has already been pointed out that procœlous, ophisthocœlous and amphicœlous forms are produced by various types of movement of the embryos at the time when the migratory connective tissue cells are actively entering the intervertebral zones of the perichordal tube.

In a heterocœlous form, such as in most birds, the formation of the vertebra is a modification of the procœlous type. Like the tadpole, the embryo of bird oscillates its body in clockwise and anti-clockwise directions, while its head is kept in a so-called stationary condition. For the mode of movement of the embryo we will have to infer it from the direction of the line of curvature formed by the migratory connective tissue cells. An analogy may be

[1] Mookerjee, H. K., *Nature*, 1934, **134**, 182.

[2] Mookerjee, H. K., *Phil. Trans. Roy. Soc.*, 1930, **218 B**, 415.

[3] *Ibid.*, 1931, **219 B**, 165.

drawn from that of the tadpole, where we can actually see that during its embryonic stage the forward movement is effected by the oscillation of the tail while its head remains stationary (Fig. 1). This leads to a change in the direction of the migratory connective tissue cells from perpendicular to the notochord, to a curve, the concavity of which is directed towards the cephalic end. The actual so-called procœlous vertebræ are formed when a split appears within the zone of curvature formed by the migratory connective tissue cells. A synovial cavity appears within the split. One point that should be noted here with regard to the formation of the heterocœlous vertebra, is that the migratory connective tissue cells instead of entering the intervertebral region in one band like that of a tadpole, enter the intervertebral region as three consecutive

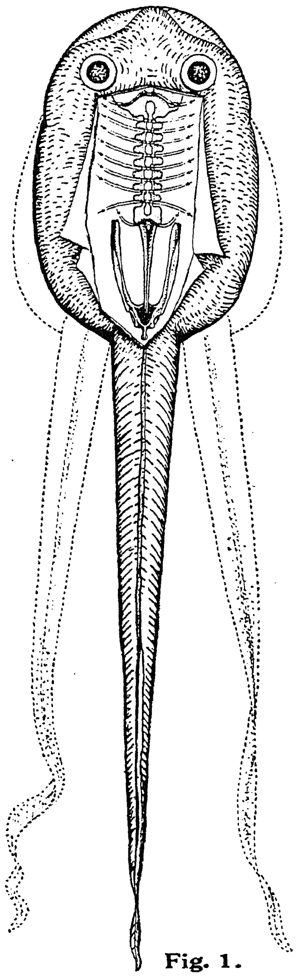

**Fig. 1.**

Diagrammatic figure of the tadpole of *Rana temporaria* on which frontal section passing through the centra of the vertebral column is superimposed. Oscillation of the embryo is shown by dotted lines. The path of migratory connective tissue cells has been shown by two consecutive lines through the intervertebral zones of the perichordal tube indicated by arrows on both sides. (After Mookerjee).

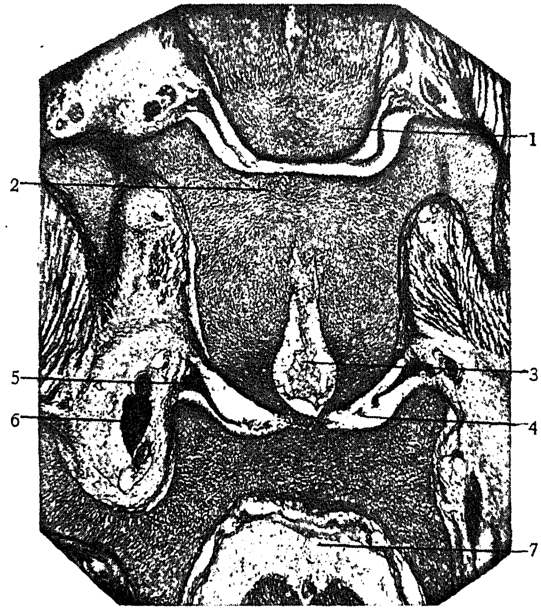


**Fig. 2.**

A Photomicrograph of the frontal section passing through the centra of three consecutive cervical vertebræ of chick embryo at 16 days incubation. ×40.

1. *vertebral condyle*; 2. *vertebral socket*; 3. *notochord*; 4. *synovial cavity*; 5. *intervertebral ligament*; 6. *spinal nerve ganglion*; 7. *spinal cord*.

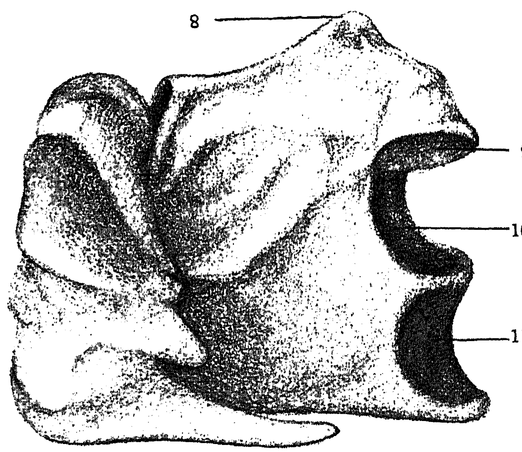


**Fig. 3.**

A side view of an adult cervical vertebra of common fowl. ×8·5.

8. *neural spine*; 9. *postzygapophysis*; 10. *neural canal*; 11. *heterocoelous vertebral condyle*.

bands as in the fry of fish.[4] The middle band quickly becomes a ligament, whereas the two lateral bands eventually become procartilaginous (Fig. 2). As in the tadpole we get here a condyle and a socket formed from the two lateral bands, and in between the two there forms a synovial cavity in which lies the intervertebral ligament. In order to accommodate this intervertebral ligament the condyle has a depression on the top (Fig. 3). The depression is also present in the socket, but would not be so prominent as on the condyle for the simple reason that the socket itself is a depression or cavity. Thus we get a heterocœlous or saddle-shaped vertebra

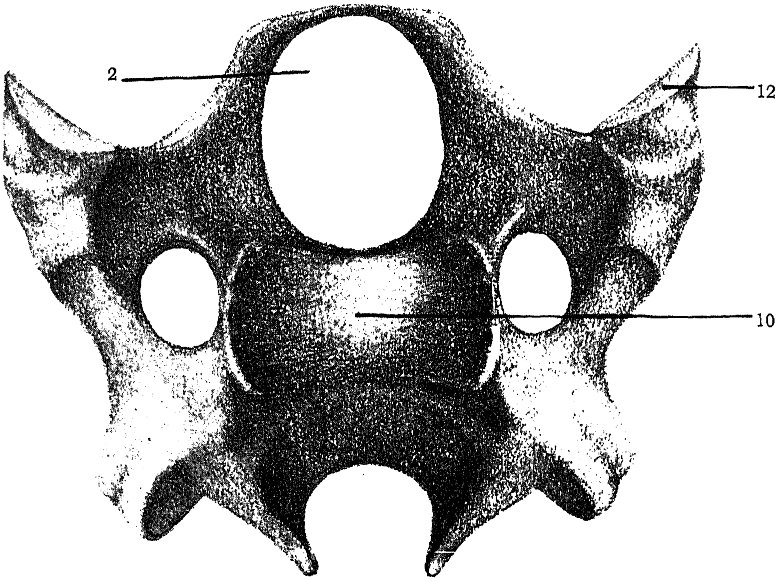


**Fig. 4.** Anterior view of an adult cervical vertebra of common fowl. × 16.
12. *Prezygapophysis.* (*Others as in* Figs. 2 & 3.)

with socket in front (Fig. 4) and a condyle at the posterior end (Fig. 5), of a vertebral centrum with a depression on the top of it, as a modified form of procœlous type (Fig. 2). Fig. 6 shows the diagrammatic

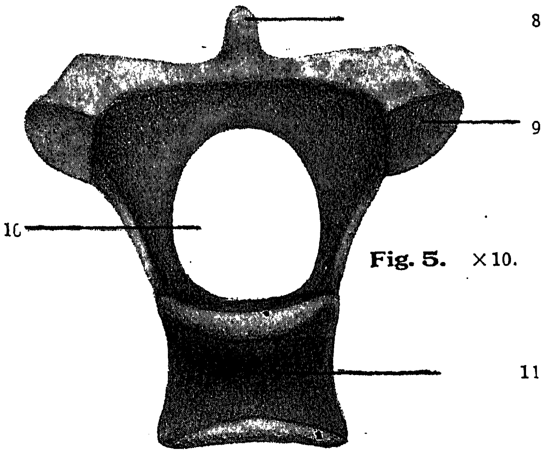


**Fig. 5.** ×10.

Posterior view of an adult cervical vertebra of common fowl. ×7·5. (*Lettering as in* Fig. 3.)

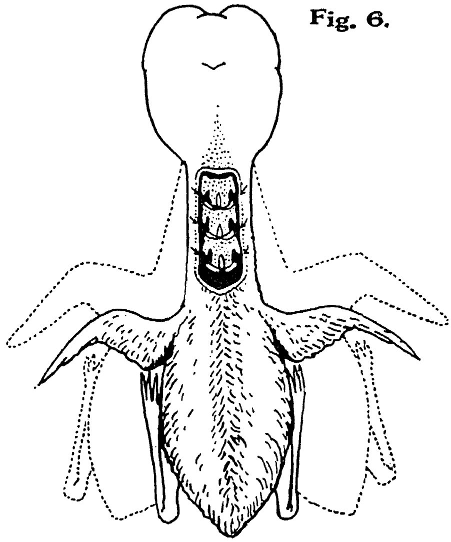

**Fig. 6.**

Diagrammatic figure of the embryo of chicken on which frontal section passing through the centra of the vertebral column is superimposed. Oscillation of the embryo is shown by dotted lines. The path of migratory connective tissue cells has been shown by two consecutive lines through the inter-vertebral zones of the perichordal tube indicated by arrows on both sides.

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[4] Mookerjee, H. K., *Curr. Sci.*, 1934, 2, 342.

view of the path of oscillation of the vertebral column of bird.

Thus we may say that those animals that oscillate their cephalic end during the embryonic stage when the migratory connective tissue cells are entering through the intervertebral zones of the perichordal tube have ophisthocœlous, and these that move their posterior portion of their body, keeping the anterior end in a so-called stationary condition generally have procœlous and when there is an intervertebral ligament intervening between the ball and socket of a procœlous vertebra we get a depression on the top of the ball of the centrum in order to accommodate the intervertebral ligament forming a heterocœlous vertebra, while those that do not oscillate their body and keep them in a so-called stationary condition generally have amphicœlous vertebra.

So we may conclude in the words of Prof. MacBride, "Habit changes first and structure a long time afterwards. Habit is the real driving force in evolution."

## Irrigation Research in the Bombay Presidency.

1. The Special Irrigation Division was opened in June 1916 and in 1927 the Irrigation Development and Research Circle was created to apply the results of research on a large scale.

In 1930 the Development and Research Division was opened in Sind. Owing to shortage of funds the Irrigation Development and Research Circle was abolished in 1933 on the recommendations of the Reorganisation Committee. Land drainage—which amounts to application of research—has been handed over to the local engineers, and research work to a new Irrigation Research Division. Continuity has been maintained due to the application of research being controlled by the same officer who previously directed research.

2. When waterlogging and salt efflorescence investigations were started in 1916, soil physics was found to be an exceedingly important factor. A staff of agricultural graduates was gradually built up under whom sub-soil classification from surface indications was worked out. This was a long and many-sided investigation of great interest—covering geology, soil physics, ecology, and the flow of sub-soil water. These investigations led to an entirely successful theory regarding drainage requirements being evolved. Since then several drainage schemes have been constructed by the Special Irrigation Division, with highly satisfactory results.

3. Simultaneously the disposal of the sewage effluent from Poona was undertaken—using it to irrigate a large cane area to the east of Poona. To investigate this question 60 acres of land were acquired near Hadapsar.

4. The corollary to the solution of the drainage problem was that of reclaiming damaged land. In many parts of the Canal tracts reduction of waterlogging combined with good cultivation was sufficient to restore the condition of the soil, but research had to be done in connection with soils, which had been damaged by salt efflorescence as a result of which they had become sodiumised.

5. The first drainage and reclamation works were carried out at the Baramati Experimental Salt Area (on the Nira Left Bank Canal) where some 160 acres of the worst land in any of the Canal tracts were acquired and drained. Of the 134 acres of land in the Baramati Experimental Salt Area, 100 acres are now suitable for growing good crops of sugarcane.

6. Drainage and reclamation methods soon gave promising results; so problems in connection with irrigation—by which is meant "increasing the fertility in soils by an artificial supply of water"—were then investigated. The policy regarding irrigation was *to modify agricultural methods to fit irrigation limitations, and to mould irrigation practice to meet agricultural requirements.*

7. This necessitated improved control of water by measuring and regulating devices, which led to the introduction of Standing Wave Flumes and Gibb modules. To perfect the design of these and other measuring devices, model experiments were started. These proved highly successful, and the work done at the Hydrodynamical Research Station soon became widely known, so that requests to test designs by models were frequent. This work became so important largely because of the remarkable facilities at Poona—that many problems concerning Sind irrigation—especially in connection with Sukkur Barrage and Canal designs—were dealt with.

These included:

- *(1) Modification of design of Barrage floor to keep the standing wave close to the Barrage under all conditions of flow.
- *(2) Best design for Barrage piers.
- †(3) Best design of divide walls.
- ‡(4) Silt exclusion from Barrage Canals.
- §(5) Dissipating energy below falls.
- (6) Silt exclusion from Mithrao Canal.
- (7) Coefficients of discharge of Barrage Gates on running and falling gauges.
- (8) Relative merits of various types of falls for dissipating energy.

Hydrodynamical research work is steadily widening in extent and importance—largely due to the new Research Station at Khadakvasla near Lake Fife (11 miles from Poona) where very exceptional facilities for discharges of clear water up to 500 cusecs under constant head are available.

8. One of the direct results of drainage research was the necessity for restricting sugarcane irrigation in the absence of drainage. The whole of

*(1) & (2) *Technical Paper* No. 29.

†(3) *Technical Paper* No. 52.

‡(4) *Technical Paper* Nos. 45 and 46.

§(5) *Technical Paper* No. 41.

the Deccan canal areas have therefore been surveyed as regards substrata and subsoil water levels and their connection with irrigation and percolation from channels.

Based on this, soils have been classified as regards permissible intensity of irrigation—with and without land drainage—and limits of cane irrigation have been fixed by catchments and sub-catchments.

Similarly fruit gardens have been restricted to areas where the most suitable soil-cum-drainage conditions will continue to prevail.

9. The block system, originated in 1906 by Sir M. Visvesvaraya, has been improved by unitisation and standardisation and is now enforced on all the Major Canals in the Deccan.

10. In Sind the Development and Research Division was opened in 1930. Under it complete subsoil surveys of the Lloyd Barrage areas have been made and maintained up to date; much work has been done on models of various masonry works, resulting in standardisation of design; investigations into flumes, falls and flow in channels are in hand, and an important silt survey of the Indus, the Nara and the Jamrao Canal is also being carried out.

11. The formation of a Central Committee of Research, subsidiary to the Central Board of Irrigation, which was formed a few years ago, was a step of immense importance to the future of all-India Irrigation Research.

12. 25 Bombay Public Works Department Technical Papers dealing with the researches carried out in the Deccan and 10 dealing with those in Sind have been published and are obtainable from the Superintendent, Government Printing and Stationery, Bombay; through the High Commissioner for India, India House, Aldwych, London, W.C. 2; or through any recognised Book-seller.

# Research Notes.

## On a Theorem of Milloux.

DINGHAS (*Math. Zeit.*, 39, pp. 590–596) has succeeded in generalising a theorem due to Milloux about integral functions of infinite order, by means of which he proves some results about a class of integral functions of infinite order which are analogous to some theorems in the theory of integral functions of finite orders—*e.g.*, Phragmen-Lindlöf theorem and Denjoy-Ahlfors theorem—on the maximum number of asymptotic values of an integral function of finite order. The theorem that he proves (analogous to Phragmen-Lindlöf theorem) at the outset is that if an integral function $f(z)$ satisfies the conditions set forth below in the infinite strip defined by $z = x + iy$,

$$x \geq 0, \ |y| \leq \frac{\pi}{2k},$$

$$\lim_{n \to \infty} e^{-\rho x} \operatorname{Log} M_0(x) = 0,$$

$$[\rho > 0, \text{ and finite}]$$

$$\lim_{n \to \infty} e^{-\rho x} \operatorname{Log} M(x) = \sigma \neq 0$$

where $M_0(x) = \operatorname{Max} \left| f\left(t \pm \frac{\pi i}{2k}\right) \right|$ for $0 < t \leq x$,

and $M(x) = \operatorname{Max} |f(x+iy)|$ for $|y| \leq \frac{\pi}{2k}$,

then $k \leq \rho$.

The proof of this theorem depends on the following lemma. If $g(z)$ is an integral function, satisfying the conditions

$$\left| g\left(x \pm i\,\frac{\pi}{2k}\right) \right| \leq M_0. \quad |g(x+iy)| \leq M,$$

$$|g(iy)| \leq M_0 \quad \text{in } 0 \leq x \leq a, \quad |y| \leq \frac{\pi}{2k}$$

(It is supposed that $M_0 < M$)

then $\log |g(z)| \leq \log M_0 + \frac{4}{\pi} \log \frac{M}{M_0} e^{k(x-a)}$.

After the proof of this theorem he introduces the notions of order, type, etc., for a class of integral functions of infinite order. [The order $\rho$ is defined as $\operatorname{Lim} \frac{\log \log M(x)}{x}$, where $M(x)$ is the maximum of $|f(z)|$ for $|y| \leq \frac{\pi}{2T}$. With these definitions he proves the following interesting result.—There does not exist any integral function of order $\rho$ (in the new sense) in a strip of breadth less than $\frac{\pi}{\rho}$ and which is of minimal type if it is of the same order in any sub-region of the strip and which is of either the maximal or the normal type. After proving another lemma he deduces another interesting result in connection with this class of integral functions which is analogous to the Denjoy conjecture about the asymptotic values of an integral function of finite order which was proved by Ahlfors in 1930.

K. V. I.

## On the Prime-Numbers of Some Arithmetical Progressions.

ERDOS (*Math. Zeit.*, 39, pp. 473–491) develops a method for the proof of the

Bertrand-Postulate in the case of prime-numbers of an arithmetical progression $a+nd$ $[(a,d)=1]$. On account of the generalised prime-number theorem the Bertrand-Postulate (that there exists prime-numbers out of $a+nd$ between $\xi$ and $2\xi$) is true provided $\xi$ is taken sufficiently large. [The limit depending on $a$ & $d$.] Breusch had proved by considering the numerical positions of the first few zeros of the corresponding $\zeta$-function that Bertrand's Postulate is true in the case of the progressions $3n\pm 1$, $4n\pm 1$, if $\xi > 10^6$, and by reference to a prime-number table he reduced the upper limit $10^6$ to 7. The author's method is elementary and as such it is applicable in the case of only a few progressions. The method is analogous to the Tchebechef proof of the theorem that $\pi(n) = O\left(\frac{n}{\operatorname{Log} n}\right)$. He introduces an integral expression

$$P_n(a,d) = \frac{\prod\limits_{p|d} p^{\left[\frac{n}{p-1}\right]} \prod\limits_{k=1}^{n} (a+kd)}{n!}$$

and proves some results in connection with its order and its structure (*viz.*, divisibility by primes, etc.). It is interesting to note that this method also enables him to give *elementary* proof of Dirichlet's theorem about the occurrence of an infinite number of prime-numbers in an arithmetical progression in the case of arithmetical progressions for which $\sigma(d) = \sum\limits_{\substack{p \times d \\ p<d}} \frac{1}{p} < 1$. By means of a numerical table which he has constructed he deduces that in all cases where $d<29$ this method is applicable; but in the case of $d=7$, 11, 13, 25 and 27, $2d$ is to be taken as the difference and in the case of $d=17$, 19, 23, $6d$ is to be taken as the difference. He also proves that if $\sigma < \frac{d-2}{2(d-1)}$ then Bertrand's Postulate about the progression $a+nd$ is true if $\xi$ is chosen sufficiently large. This applies to progressions of the form $6k\pm 1$, $12k\pm 1$, and $12k\pm 5$. ($\therefore 4k\pm 1$.) In the case of $d=6$, the sharper result that there exists a prime-number of the progression between $\xi$ and $1 \cdot 5\,\xi$, is true if $\xi$ is chosen large enough. He next sharpens this result to the case when $\sigma < \frac{1}{2} - \frac{d}{(d-1)(2d+1)}$. He also calculates the lower limits for $\xi$ in the case of a few arithmetic progressions. The lower limits obtained are far s than those obtained from the fun theory method.

K.

## The Theory of Reduced Simple Conti Fractions (*Reduziert-Regelmässiges K Brüche.*)

ZURL (*Math. Ann.*, **110 B**, 5 Heft, pp. 67 has developed completely the pro of this type of continued fractions. Re simple continued fractions are continue tions of the following form $b_0 \frac{1|}{|b_1} \frac{1|}{|b_2}$ where $b_v$'s are positive integers $b_v \geqslant 2$ for $v \geqslant 1$. The paper is d into three chapters. The first chapte with the introduction to the theor concerns itself with the simple proper convergents $\frac{A_r}{B_r}$, and the developme any number as a continued fraction c type. Here are some of the inter results (1) $\frac{A_r}{B_r}$ decreases monoton

(2) $\underset{v\to\infty}{Lt} \;|B_v - B_{v-1}| = \infty$,

(3) $\frac{B_{r+k-1} \quad B_{r+k-2}}{B_{r+k-2}} > \frac{1}{k}$.

The second chapter is devoted to the st the way of approach of the conve towards the number which is develo a continued fraction of this type. tions for a fraction to be a converge reduced simple continued fraction de ment of an irrational number are which are analogous to the conditi the case of the ordinary continued fr development. We come across certain esting results in the third chapter. we find a detailed and systematic st periodic continued fractions of this Results some of whom are analogous classical theorems of Lagrange and in connection with ordinary periodic continued fractions are enunciated proved. The paper also contains a which gives us the developmen $\sqrt{D}$ [D = 2 to 99] as a continued fract this type. These developments p one advantage over the ordinary cont fraction development; for, we can the diophantine equation $x^2 - Dy^2 =$

means of the former for $|k| \leqslant 2\sqrt{D}$ and whereas by means of the latter we can solve the equation only for $k \leqslant \sqrt{D}$.

K. V. I.

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### "Bleeding of Cements."

ORDINARY Portland Cement when used for making concrete blocks, has a tendency to separate itself from the excess water used in the mixture, which has been termed "bleeding". Very often, this leads to disastrous results in dams and retaining walls on account of the voids created by the free water which is subsequently removed by evaporation or otherwise. It is usually found that cements of abnormally low surface area exhibit an excessive tendency to bleed. One of the ways of getting over the trouble has been in using Portland Cement ground to a fine state of division. The latest development in this field has been, in grinding standard cement clinker to a superior degree of fineness in presence of a small amount of organic dispersing agents which consist of polymers of condensed naphthalene sulphonic acids. An exhaustive study has been made by L. S. Brown (*Ind. Eng. Chem.*, 1935, **27**, 79) who has shown that the addition of such dispersing agents reduces the porosity of the gel; hence the loss of water and the formation of voids in the concrete is considerably diminished.

M. P. V.

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### The Vitreous State.

G. HÄGG (*J. Chem. Phys.*, 1935, **3**, 42) correlates the tendency for the formation of amorphous melts with the existence of atom groups kept together with strong attractive forces. A melt having such structures so large or irregular as to render the addition to a crystal lattice difficult shows a large tendency for supercooling and glass formation. Metals and simple compounds, which show little tendency to formation of such large or irregular groupings, do not form vitreous solids. On the other hand, a large class of substances such as the oxides of certain metalloids (such as Si, B, Ge) and the corresponding acids and salts show this quality in a large measure. This behaviour is attributed to the tendency on the part of metalloid atoms to co-ordinate oxygen in a definite way, which brings about the formation of complex structures which retard crystallisation. This hypothesis gives a rational interpretation of the diminished tendency to form glass-like melts in certain systems as the percentage of basic oxide is increased.

K. S. G. D.

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### Activation of Papain and Cathepsin.

RESULTS of a far-reaching character have been indicated by Purr (*Biochem. J.*, 1935, **29**, 13) in the course of his extensive investigation on the relation between intracellular enzymes and vitamins. It was known, for some time past, that sulphydryl compounds are specific activators for proteinases. In 1933, Purr discovered that vitamin C–Fe″ complex activated cathepsin and arginase and later Maschmann and Helmert (1934) showed that papain, a proteinase of vegetable origin, was activated by vitamin C in presence of bivalent iron salts, the vitamin C–Fe″ resembling in this respect HCN. The investigations reported in this paper show that the activation brought about by different agencies are all of a similar character.

Both vitamin C–Fe″ and pyruvic acid–Fe″ activate papain only indirectly, as they are unable to activate purified, reversibly-inactivated papain (prepared according to the method of Purr [*Biochem. J.*, 1935, **29**, 5]. Unpurified commercial papain, on the other hand, is readily activated. From the observation on the effect of fixed SS-proteins on the activation phenomena of papain, it can be concluded that unpurified commercial papin contains fixed SS-forms of protein which the vitamin C–Fe″ complex in the presence of the papain complex converts into the SH-form. Neither the vitamin C–Fe″ nor the papain can bring about the reduction individually. Similarly when oxidised glutathione and vitamin C–Fe″ are added to inactive papain, the reduction of oxidised glutathione (or oxidised papain ?) is brought about. The activation of papain by vitamin C–Fe″ apparently depends on the presence of SS-groups either in the glutathione molecule or in the fixed SS-protein. The real activators of papain are the sulphydryl compounds and the observed activation by HCN, and by vitamin C, pyruvic acid and succinic acid in the presence of bivalent iron, is an indirect effect.

The activation phenomena of cathepsin are essentially similar to those of papain. The author concludes that papain and cathepsin in the active state are fixed

SH-proteins of definite constitution, while the reversible inactivation forms of these enzymes appear to be SS-forms.

B. N. S.

### Occurrence and Distribution of Diatoms in the Punjab.

*The Journal of the Asiatic Society of Bengal* (1934, **29**, 307-309) contains "A Short Note on the Occurrence and Distribution of Diatoms in the Punjab" by M. Abdul Majeed. The author has pointed out that the bare wet garden lawns generally harbour a few species of *Navicula* and *Nitzschia*. The ponds, pools and tanks are the most productive places and the epiphytic Diatoms form an interesting part of the study of the algal-flora of the Punjab. Species of *Surirella* which are common in other districts have not been found in Lahore, whereas species of *Rhopalodia* and *Epithemia* seem to be restricted to Lahore and its outskirts. According to the author species of *Asterionella* and *Tabellaria* so prevalent in Europe seem to be absent in the Punjab.

### Germ Layers of Certain Diprotodont Marsupials.

T. KERR has described some early blastocysts of certain Diprotodont Marsupials (*Quar. J. Micro. Sci.*, 1934, **77**, Pt. II, No. 306) and has studied the formation of the germ layers. An almost complete series of blastocysts from the unilaminar stage to that showing the appearance of the first rudiments of mesoderm has enabled the author to describe the origin of the endoderm and mesoderm. The former arises as a number of isolated mother cells which migrate inwards and forms a continuous layer, similar to that described by Hill in Dasyurus. Large included cells from which Hartmann derives the endoderm in Didelphys are rare and when they are present, show obvious traces of degeneration. The mesoderm arises as an active proliferation of cells of the ectoderm in the formative area. At first continuous with the ectoderm, this heap of cells later separates and forms a distinct layer.

### The Zoological Relationship of the Conodonts.

FROM a long time there has been a keen controversy regarding the exact zoological affinity of the conodonts. The vertebrate palæontologists seldom claim them as remains of vertebrates, and the invertebrate palæontologists hesitate to classify them among the invertebrates. Thus there has been a tendency for each group of workers to force the ownership upon the other group. Indeed this group of animals seems to be mysterious since their remains have been classified in such diverse groups as Pisces, Annelids, Mollusca, Crustacea, etc. But for a long time, however, they have been regarded as the remains of a certain group of fishes. In a recent communication to the *Journal of Palæontology* (Vol. **8**, No. 4), H. W. Scott has made a detailed study of the conodonts from the shales of the Quadrant formation. From the characters he has deduced that the conodonts have a greater affinity to the group of Vermes rather than to fishes.

### Sedimentation and Stratigraphy from Modern Points of View.

W. H. TWENHOFEL, the author of the well-known work *Treatise on Sedimentation*, has rendered a distinct service for geologists and sedimentary petrologists in particular, by reviewing the development of the study of sedimentation and stratigraphy from the earliest times, in his lecture before the Society of Economic Geologists and Mineralogists (*Journal of Pal.*, **8**, No. 4). The findings of most of the geologists like Wrener and Cuvier have been challenged since they were based on incomplete observations and in certain cases on lack of knowledge. Of late the detailed study of sediments especially by Barrell, Milner and Boswell has shown that sedimentation is a complex process and that all like sediments need not have the same history. The process itself depends upon a number of variable factors and the sediments should therefore be studied as products of environmental conditions. In the words of the author "the sediments are not dead substances, but fragments of ancient history of which the reading is destined to make necessary the rewriting of much geologic history and the redrawing of much ancient geography". The common tendency to make generalisations regarding the origin of similar sediments must be avoided. Each must be studied independently and therein lies the key to the palæogeographical conditions of the past.

## The Skull of Holocephali.

OUR knowledge about the fish skull is far from being complete and recently a comprehensive account of the Teleostean skulls was published by William K. Gregory. The primitive groups like Holocephali have received very little attention and the paper by G. R. de Beer and J. A. Moy Thomas in the *Phil. Trans.*, 1935 B., **514**, is certainly welcome. The former author by a careful study of the available embryological material of Holocephali elucidates the real nature of the palatoquadrate attachment, the structure of the hyoid arch and the nature of the so-called ethmoidal canal. The pterygoquadrate is fused to the neuro cranium and an otic process is present. The skeleton of the hyoid arch is primitive and possesses pharyngohyal and epiphyal; it is non-suspensorial. The presence of the pharyngohyal points definitely to the conclusion that the ancestors were never amphistylic or hyostylic. The group Holocephali must have taken its origin from autodiastylic ancestor, from which also the selachian must have radiated. Thus the selachians are closely related to Holocephali. The third point which is stressed in the paper is about the ethmoidal canal; this canal is an extra-cranial space secondarily roofed over when the interorbital septum is formed.

## Science Notes.

*An Interesting Implement for Mud-fishing from Uttarbhag, Lower Bengal.*—At a meeting of the Asiatic Society of Bengal held on 4th March, Dr. S. L. Hora gave an account of a device for securing *Jiol Machh* from marshy areas in Lower Bengal. "A circular basket of the usual material and make, about 9½ inches in diameter and 23 inches in total length, is used. One end of the basket is open and the mouth is strengthened by a circular band of broad bamboo-strips. At a distance of about 16 inches from the mouth, there is another band of bamboo-strips, after which the split-bamboo sticks are pulled together and secured by a loop of string. The loop is fastened to the nearest band. In this way, the other end of the basket is closed and made to serve as a handle for manipulating the basket.

"The split-bamboo sticks, which run lengthwise, are about half an inch apart so that when the open end is dragged through mud, it passed out through the wide spaces and only the fish are trapped inside the basket."

* * *

*A Note on the Distribution of* Gloriosa superba *Linn. (Vern:—Bechnag, Kulhari, Bisha, etc.) towards Vikarabad and its medicinal importance.*—Messrs. M. Sayeeduddin and M. Abdus Salam, write: "We pointed out in our previous communication to *Current Science*, Vol. II, No. 3, Sept. 1933, p. 83, that, while ascertaining the distribution of *Lantana camara* Linn. towards Vikarabad we met with at a spot about 24 miles from the Hyderabad city a striking association of Lantana, *Gymnosporia montana*, *Butea frondosa*, *Tectona grandis*, *Dodonæa viscosa* and *Gloriosa superba* of which the last named was found evidently for the first time in our excursions towards this side. There is no definite record of its having been found this side before. The only reliable information one can get of the Hyderabad vegetation is from two works namely *Forest Flora of Hyderabad, Deccan* by E. A. Partridge (Pub. 1911) and from *The Madras Journal*, Vol. XV (Pub. 1848) in which there are abstracts of botanical reports about Warangal and Dawlatabad districts. Partridge writes (p. 402) that "*Gloriosa superba* is very common everywhere, springing up after the rains in field-hedges and on the outskirts of forests." Later on he mentions "Common in hedges, chiefly on black cotton soil." The latter statement makes us believe that his observations were made chiefly towards the Marhatwari side where the soil is mostly black and very suitable for the growth of cotton. No mention is made about this plant in the *Madras Journal* either, in which besides others, many plants of medicinal importance have been recorded. *Gloriosa superba* too happens to possess a few valuable medicinal properties (*ref.* Kirtikar, *Ind. Med. Plts.*, and Watt, *Dict. Econ. Prod. I.*) and it is strange that this plant has escaped the notice and consideration of the author of the above botanical reports.

It was summer time when we last visited Vikarabad. But in order to make a preliminary survey of its vegetation during the rainy season we undertook an excursion recently in August 1934. What was most striking is the gradual spread of *Gloriosa superba* and its association with *Gymnosporia montana* (Family Celastraceæ) whose root-action is claimed by Mr. Abdur Rahman Khan (*ref. Osmania University Research Jour.*, 1934), to be one of those responsible for turning rocks into *morum*. In all the cases mentioned below *Gloriosa superba* was found chiefly on *Gymnosporia montana*, which seems to prefer rather dry situations and hard substratum. While *Gloriosa superba* does not seem to be restricted to any particular kind of soil, it seems to have its own associations.

The exact spots where this plant was found within a distance of about 52 miles from the Hyderabad city are the following:—

16 miles and 7 furlongs from the city—A single plant on *Gymnosporia montana*. Between 16 and 18 miles—At two spots again in the same association. Between 18 and 19 miles—At several places with *Gymnosporia*, profusely in flower. Between 20 and 21 miles—All cultivated land, in some places slightly hilly. No trace of *Gloriosa*. At 21 miles.—*Gloriosa superba* amongst dense vegetation consisting of *Gymnosporia*, *Dodonæa viscosa*, *Zizyphus* sp., and several herbs. Between 21 and 44 miles—No trace of *Gloriosa*. After this nearing Vikarabad it was noticed at one spot only. But it was to be found again in

the thick forest at "Anant Giri", a hill about 2 miles from the Vikarabad village.

It seems probable that *Gloriosa superba* has ultimately found its way towards Vikarabad from the Bombay side where it is met with in abundance. It seems to have followed the other course also from Bombay, that is *via* Aurangabad towards Hyderabad, and it was on this side, we believe, that Mr. Partridge made most of his observations as is evident from his statement that *Gloriosa superba* is found chiefly on black cotton soil. It is quite probable that *Gloriosa superba* has found its way recently towards Vikarabad. Further investigations are in progress.

* * *

*Goat Breeding in Western India.*—The Imperial Council of Agricultural Research has recently provided funds for a scheme of goat breeding to be conducted by the Government of Bombay.

There are two well-defined pure breeds of goat in Western India, (1) the Surti, a small cream-coloured, hornless animal, reared on stall feeding, and (2) the North Gujarat goat, largely reared on grazing and principally used for meat and hair production. The scheme is intended (*a*) to study the two breeds, the inheritance of their characters, their feeding and management contributing to high milk production, (*b*) to conduct feeding trials to ascertain the most suitable quantities and qualities of Indian foodstuffs and their most desirable combinations for high milk production and growth, and (*c*) to investigate the comparative hygienic and food value of goat milk for feeding children, patients and invalids.

The scheme will extend over a period of 10 years and the work will be carried out at 3 stations, Poona, Vadala and Ankaleswar. The Live-stock Expert to the Government of Bombay and the Nutrition Assistant with the co-operation of Mr. I. W. Moomaw and Rev. R. W. Fairbank will conduct the investigations.

* * *

*Agricultural Research Institute, Delhi.*—His Excellency the Viceroy performed the ceremony of laying the foundation stone of the Imperial Institute, at New Delhi on the 19th February. In the course of his speech His Excellency pointed out that the location of the Institute at Delhi which being more easily accessible will enable the staff to be in intimate touch with the Indian scientific workers, will remove the atmosphere of isolation, from which the Institute, situated as it was at Pusa, suffered so far.

Referring to the nature of research which the Central Institute will undertake, His Excellency said, "There are problems of fundamental research which it is not possible for each Province with the comparatively limited resources to undertake, nor is it advisable that in the investigation of such problems there should be duplication of effort, and therefore waste of energy and money.... It is my hope that the Institute will be regarded by the Provinces as an integral part of their agricultural organisation and that they would refer to it problems which are not of purely local interest or importance and which they consider suitable for investigation at the Central Place."

"A number of young men return every year from Europe and America after taking research degrees but many of them do not at once find the employment adopted to the full utilisation of their training. Any scheme which would make it possible for some of the best of them to devote their abilities to agricultural research would be of real benefit to India. This is a direction in which private philanthropy would largely help by endowing as in other progressive countries research fellowships tenable at the Central Institute."

* * *

*Institute of Population Research in India.*—The inaugural meeting of the Indian Population Conference will be held at Lucknow during the ensuing *Dewali* holidays under the auspices of the Institute of Population Research in India. The objects of this Institute which has recently been started are briefly to stimulate and organise population researches in different provinces of India, to co-ordinate such researches as are now being undertaken, to hold general and local conferences and to publish the results of researches and discussions at such conferences from time to time.

Population questions in India will play a great part in determining practical, economic, social and political programmes and it is the purpose of the Institute to collect statistics and data and systematise and co-ordinate scientific knowledge in respect of the various elements in the population problems of the country. Researches in the following special fields are now promoted under the Institute :—(1) Population, food supply and vital statistics: (2) Population, crops and agricultural practice: (3) Population and trend of population; (4) Indices of agricultural productivity and population trend in the U. P.; (5) Standards of living and cost of living indices; (6) Population, dietary and nutrition: (7) Anthropometric measurements of the inhabitants of U. P.; (8) Comparative study of the numerical variation of different castes and communities; (9) Economic and vital decline of the primitive people of India; and (10) Migration, rural, interprovincial and overseas.

Further information regarding the Institute can be obtained from Prof. Radha Kamal Mukerjee, University of Lucknow.

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*Evaporation in India calculated from other Meteorological Factors*, by P. K. Raman and V. Satakopan. (*Scientific Notes*, *India Meteorological Department*, Vol. VI, No. 61).—The paper contains a discussion of the mean monthly and annual evaporation at 80 stations in India. The evaporation is calculated from the formula

$$E = (1\cdot465 - 0\cdot0186\,B)\,(0\cdot44 + 0\cdot118\,W)\,\left(\frac{100}{h} - 1\right)e$$

where E is the mean daily evaporation in inches, B the barometric pressure at station level in inches, W the mean wind velocity of the day at 4 feet above ground in miles per hour, $h$ the mean relative humidity and $e$ the vapour pressure in inches of mercury. Monthly and annual evaporation charts have been drawn and discussed. The values of "rainfall *minus* evaporation" at the 80 stations have been calculated: these indicate the arid and the wet zones of the country. Finally, the importance of evaporation in salt-works and its influence on plant life have been discussed.

* * *

*Earth Pressure Tables* (Building Research Special Report No. 24. H. M. Stationery Office, Price 2*s*.)—These tables, published for the first time, give data necessary for calculating the

pressure exerted by granular materials on plane retaining walls of any batter, and are accompanied by a summary of the Revised Wedge Theory in so far as is required by the practical engineer when using the tables.

* * *

*Johne's Disease of Cattle.*—A useful and timely contribution on an important disease of cattle to which much attention has been given only of late appears as Bulletin 167,—New series, Dominion of Canada, Department of Agriculture. The nature, symptoms, post-mortem appearances, mode of the spread of the infection and methods of control of the Johne's disease are described in simple language so as to be easily understood by the live-stock owner. Much is not known yet about the disease but what little is known is brought out clearly in this small brochure. This disease—like tuberculosis—is as insidious as it is fatal, scouring and wasting being its chief signs. The infection is spread by direct contact with the affected animal or through contaminated pastures, ponds, etc. As there are no known methods, yet, of cure or preventive inoculation, the only measures advocated are destruction of the affected and in contact animals or, at least, strict isolation and thorough disinfection of the premises. As there is much reason to class this among the deficiency diseases properly balanced rations with the necessary vitamins and minerals should be particularly provided to all animals.

Certain additional information such as that sheep, goats and deer are also susceptible, though to a less extent than cattle, and that the disease is more often met with in low-lying and damp areas and also that the causal agency may be found in the rectal scrapings and in the milk of affected cows might have been included with advantage.

Much work has yet to be done to investigate the extent of the incidence of the disease and to discover diagnostic, therapeutic and prophylactic agents for combating it effectively. It is most satisfactory to note that the Imperial Council of Agricultural Research has taken up this question in earnest and has also awarded a grant for investigational work in Mysore.

It would be indeed most useful if this monograph could be translated into the various vernaculars in India and distributed among the owners of cattle.—S. D. A.

* * *

*300th Anniversary of the Establishment of Chemical Industries in America.*—The American Chemical Society will be celebrating at New York this Spring the tricentenary of the first serious American Chemical enterprise by John Winthrop, Jr. This will be a happy occasion for, few, even among chemists, have realised that the chemical production of America—measured in dollars or tons—is three times that of Germany, four times that of Great Britain and probably, half of the entire world's output. Modern American Chemical Industry is built solidly on research and holds a splendid record of achievement. It may be mentioned that a recent survey of the activities of the research and process development laboratories of the chemical industries revealed the fact that during the recent depression period, research was being continued without abatement. Many new processes have been developed for making products that could not be produced economically before and many new processes have been developed that have been designed to meet the needs of new and better living conditions.

During the celebration, a symposium on the "Economic, Social, Scientific and Political Foundations of the Chemical Industries" by leading industrialists, financiers and scientists has been organised. A very elaborate programme has been arranged with the assistance of the Merchants' Association, art and educational institutions and entertainment organisations of the New York City. Messrs. Lammot du Pont, E. M. Allen and George W. Merck, will co-operate with the Committee of the American Chemical Society headed by Prof. Arthur Hixson, in making the necessary arrangements.

* * *

Prof. William Whitehead Watts, F.R.S., the famous Geologist and author of the well-known '*Geology for Beginners*' which for 40 years has "provided the first introduction of the science to young Geologists in all the English-speaking World" has been elected President of the British Association for the Advancement of Science, 1935.

* * *

*The Ramanujam Memorial Prize in Mathematics for* 1933 which was offered by the Madras University for the best thesis based on original contributions submitted by an Indian (or one domiciled in India) on some definite branch of Mathematics, pure or applied, has been divided equally among (1) S. Chandrasekhar, M.A., for his thesis entitled "Polytropic Distribution"; (2) S. Chowla, Ph.D., for "The Theory of Dirichlet's L. Functions" and (3) D. D. Kosambi, for "Notes on the Mathematical Analysis of Space".

* * *

*Element with Atomic Number* 93.—Under the title *Bohemium—an obituary*, Max Speter, in a note published in *Science* (1934, **80**, 588) draws attention to the fact that the alleged element of atomic No. 93 and atomic weight 240, discovered by Odelen Koblic has been subjected to rigorous X-ray spectrographic study by Walter and Ida Noddack at Berlin. Negative results for an element of atomic No. 93 were obtained. Chemical tests show that the specimen consisted chiefly of tungsten, vanadium, etc. and tungsten was responsible for the observation that had led Koblic into his erroneous statement.

* * *

*Irrigation Research in U.P.*, 1933–34.—The activities of the research section were confined to (1) the investigation of losses in water courses and in channels, (2) the study of the best means of lining channels and water courses, and (3) the design of distributary heads intended to exclude heavy silt. As it was of great importance to ascertain whether the lining of water courses was economically justified in tube-well projects, a very large number of experiments were undertaken to ascertain gul losses. The losses in small water courses varied with the depth of water. At present, the prevailing low prices make the lining of channels a doubtful economy. A number of fresh observations of losses in distributaries and minors showed that in general, the large channels gave smaller losses than the small ones, which fact lends colour to the view that the greater part of the losses occurs through the sides of channels. The greatest scope for lining is in small channels and water courses, and with this object several lining experiments were conducted.

A new form of lining, consisting of from one half inch to one inch thickness of cement mortar, reinforced with open weave hessian, was found useful. Tests into a number of silt-excluding heads constructed on different distributaries show that there are no means of complete silt exclusion; all that is possible is to reduce the amount. Experience on the Sarda Canal has shown that regime slopes are a function of the silt factor or type of silt transported, and that with a fine silt are associated flatter water surface slopes. Valuable silt distribution curves obtained from the Research Institute, Lahore, have shown that silt sampling is a most useful adjunct to the study of channel behaviour.

* * *

*Annual Report of the Director, Research Institute, A. & U. Tibbi College, Delhi, for the year* 1934.—This institute was started in March 1930 and is devoted to researches on the chemical constituents of indigenous medicinal plants. Valuable work on the alkaloids of *Holarrhena antidysentrica*, which has acquired immense medicinal interest through the pharmacological and therapeutic investigation of Col. Chopra and his co-workers as a cure for amœbic dysentery, has been carried out by the Director and his collaborators. The synthesis of the chief alkaloid of the plant Conessine has been achieved and this is a matter of considerable industrial significance. Among other researches carried out at the Institute, mention may be made of the work on the constitution of ajmaline and its subsidiary alkaloids, isolated from the *Rauwolfia serpentina*, Benth. These alkaloids have been successfully employed as a cure for violent insanity, chronic insomnia and chronic uterine and intestinal sluggishness. The work relating to the alkaloids of *Cassia absus*, Linn. also deserves mention.

In this report, the Director has stressed the need for expanding the Institute so as to include a Pharmacological Section. This is only appropriate as the work of the Institute is of a specialised character and calls for the co-operative efforts of organic chemists and pharmacologists. We hope that the authorities would be able to supply this long-felt want at an early date.

* * *

*Indian Chemical Society—Eleventh Annual General Meeting*, 1935.—At the annual meeting held on the 4th January 1935 with Dr. N. R. Dhar, the President of the Society, in the Chair, the following office-bearers were elected:—

*President*: Sir U. N. Brahmachari (1935-36); *Vice-President*: Sir Martin Onslow Forster (1935-37); *Honorary Secretary*: Prof. R. Ray (1935); *Honorary Treasurer*: Dr. Sudhamoy Ghosh (1935); *Honorary Auditors*: Mr. P. C. Nandi and Mr. J. P. Mookharjee (1935); *Ordinary Members*: Prof. R. N. Sen (Bengal) 1935-37; Dr. T. S. Wheeler (Bombay) 1935-37; Dr. P. C. Guha (S. India) 1935-37; Dr. K. R. Krishnaswami (S. India).

The President presented the Sir P. C. Ray 70th Birthday Commemoration Medal for 1933 to Mr. Susil Kumar Ray for his work on "Polyhalides" adjudged to be the best paper for the competition.

The President announced that Mr. Pulin Behari Sarkar has been recommended by the Board of Examiners for the J. M. Das Gupta Medal.

A Special Committee of the Council was formed in order to consider the advisability of instituting Associate membership, publishing news bulletin and abstracts of papers in the *Journal of the Society*.

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We acknowledge, with thanks, the receipt of the latest number (Vol. VI, No. 4, Dec. 1934) of the *Quarterly Journal* published by the Geological, Mining and Metallurgical Society of India, Calcutta. The Society has to be congratulated on having successfully run the journal for these six years, thus providing a means of publication for several important papers on geological and allied subjects from workers in different parts of India. The general get-up of the journal is quite good. It strikes us, however, that the rates of subscription charged (Annual Rs. 16, Single copy Rs. 6) are a little too much, even after providing a wide margin for the high cost of scientific publication in India. We wish the journal a useful and prosperous career.

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We have received three numbers of Volume I of *Marriage Hygiene*, a new Journal which is published from Bombay under the Editorship of Dr. A. P. Pillay. The journal is intended to diffuse sane and scientific ideas of sex problems and the use and technique of contraceptic methods among the educated Indians. Writing about the journal, Mrs. Edith How-Martin expresses as follows:—

"If this new journal of *Marriage Hygiene* can help to bring the light of scientific knowledge to bear upon and to overcome even some of the prejudices and social and religious taboos with which marriage is surrounded, it will make a notable contribution to human happiness."

Our sentiments are identical. The number for February 1935 contains articles written by the well-known writers like, Havelock Ellis, W. F. Geikie-Cobb, G. L. Gillin, R. R. Awati, Waldemar E. Coutts, Paul Popenoe, G. S. Ghurye, A. R. Kaufman and others.

We acknowledge with thanks the receipt of the following:—

"Actualites Scientifiques et Industrielles", Nos. 161, 163, 164, 165, 167, 170-175; 178-179; 181, 188, 191, 195, 197, 198, 205 and 208. (Hermann et cie, Paris).

"Journal of Agricultural Research," Vol. 49, No. 9, Nov. 1934; Index to Vol. 48, Jan. 1 July 15, 1934.

"Journal of Agriculture and Live-stock in India," Vol. 5, Pt. I, January 1935.

"The Journal of the Royal Society of Arts," Vol, 83, Nos. 4288-4291.

"Indian Journal of Agricultural Science," Vol. 4, Part VI, December 1934.

"Journal of the Annamalai University," Vol. IV, No. 1, January 1935.

"Biochemical Journal," Vol. 28, No. 6, Vol. 29, No. 1, 1935.

"American Journal of Botany," Vol. 22, No. 1, January 1935.

"The Journal of the Institute of Brewing," Vol. 41 (Vol. 32—New Series), No. 2, February 1935.

"Canadian Journal of Research," Vol. 12, No. 1, Jan. 1935: and Index to Vol. 11, July-Dec. 1934.

"Chemical Age," Vol. 32, Nos. 813-816.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 2.

"The Journal of the Indian Chemical Society," Vol. 12, No. 1, January 1935.

"Experimental Station Record," Vol. 71, No. 6; Vol. 72, No. 1.

"Indian Forester," Vol. 61, No. 2, February 1935; No. 3, March 1935.

"Forschungen und Fortschritte," Vol. 12, Nos. 1-6.

"The Quarterly Journal of Geological, Mining and Metallurgical Society of India," Vol. 6, No. 4.

"Report on the 3rd Imperial Mycological Conference," 1934.

"Report of the 22nd Annual Conference of Educational Associations," held at the University College, London, 1934.

"Union of South Africa Fisheries and Marine Biological Survey" Report No. 11, for the year ending December 1933.

"Report of the Fermentation Industries for 1934," by R. H. Hopkins and F. W. Norris.

"Second Report of the Royal Institute of Science, Bombay" (1926-1934).

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. 4, No. 4, December 1934.

"Scripta Mathematica," Vol. 3, No. 1, January 1935.

"Nature," Vol. 135, Nos. 3404-3407.

"Natural History," January 1935 and February 1935.

"The Journal of Nutrition," Vol. 9, Nos. 1 and 2.

"Journal of the Osmania University College," Vol. 2, 1934.

"The Journal of Chemical Physics," Vol. 3, No. 2.

"Journal de Chimie Physique," Tome 31, No. 10; Tome 32, No. 1.

"The Indian Trade Journal," Vol. 116, Nos. 1494-1498.

"Indian Journal of Medical Research," Vol. 22, No. 3, January 1935.

"Marriage Hygiene," Vol. 1, Nos. 1-3, 1934-35.

"Department of Commercial Intelligence and Statistics, India,—Monthly Statistics of the Production of Certain Selected Industries of India," October 1934, No. 7 of 1934-35.

"Bulletin of the Patna Science College Philosophical Society," No. 5, January 1935.

# Academies and Societies.

## Indian Academy of Sciences.

(*Proceedings*, Vol. 1, No. 8.)

### SECTION A.

B. V. RAGHAVENDRA RAO: *Examination of Molecularly Scattered Light with a Fabry-Perot Etalon. Part II. Liquids: Toluene and Carbon Tetrachloride.* It is found that the relative intensities of the central to the outer Doppler components is much greater for carbon tetrachloride than for toluene. The shift, reported by Cabannes, of the central Rayleigh line towards the red is unreal and is due to the fluctuations of temperature and pressure of the surroundings. T. S. SUBBARAYA: *On the Analysis of the Band Spectrum of Cadmium.* The peculiar behaviour of the ground state, observed by the author for mercury, in having $\Delta F''$s which increase at first and then decrease, and in having a large anharmonic term, is found also in the case of cadmium. M. A. GOVINDA RAU AND B. N. NARAYANASWAMY: *Effect of Solvent in Dipole Moment Measurements. Polarisation and Moment of Nitrobenzene.* Six different solvents have been used, and the structure of the $-NO_2$ group is discussed. M. A. GOVINDA RAU: *Theory of the Solvent Effect in Dipole Moment Measurements.* On the basis of the theory of Raman and Krishnan of anisotropic field constants prevailing in a liquid medium, a rigorous expression is derived for the polarisation of a solute in infinite dilution in a non-polar solvent, after eliminating the influence of the solvent. A. N. MELDRUM AND K. S. VAIDYANATHAN: *Synthesis of Substances Related to Cochinillic and Carminic Acids.* The synthesis is effected through the condensation of chloral with 5-hydroxy-*m*-toluic acid. S. CHOWLA: *On Sums of Powers.* S. CHOWLA: *Some Infinite Series.* S. CHOWLA AND S. SASTRY: *On Sums of Powers.* P. K. SESHAN: *Chemical Studies on Coal.*—A study of a number of coals from the Indian and the American coalfields shows that cellulose is destroyed very much more rapidly than lignin at the earlier stages, and more slowly than lignin at the later stages of coalification. R. K. ASUNDI, C. M. BHASKER RAO AND R. SAMUEL: *On the Absorption Spectra of Some Organo-Metallic Compounds.*—Dimethyl, diethyl and diphenyl mercury, and diphenyl lead are among those studied in the vapour state. The results are discussed with Frank-Condon diagrams. K. NAGABHUSHANAM: *On the Form* $\sum_{r=1}^{n} p_r\, dq^r$ — *Hdt.* S. CHOWLA: *The Lattice Points in a Hypersphere.*

### SECTION B.

S. S. PATWARDHAN: *On the Structure and Mechanism of the Gastric Mill in Decapoda. III—Structure of the Gastric Mill in Anomura.*—The seven types of Anomura examined contained a complex gastric mill. A brief account of the cardiac and the pyloric stomach and a comparative account of the principal ossicles of the gastric mill is given. S. S. PATWARDHAN: *On the Structure and Mechanism of the Gastric Mill in Decapoda. IV.—The Structure of the Gastric Mill in Reptantous Macrura.*—The suborder Macrura can be divided into two groups (*a*) Reptantous Macrura comprising crayfishes and lobsters, and (*b*) Natantous Macrura comprising prawns and shrimps. The former group is characterised by a universal presence of the gastric mill. BAHADUR SINGH AND T. N. SHIVAPURI: *The Gametophytes of* Neptunia oleracea, *Lour.* B. N. SINGH AND R. S. CHOUDHRI: *Induced Morphological, Physiological and Chemical Variations Following Seed-Exposure to X-Radiation in* Nicotiana tabacum.—As a result of the treatment with softer doses more vigorous and healthy crops can be produced. Variabilities in offspring are produced by X-radiation. T. EKAMBARAM AND RAMA RAO PANJE: *Contributions to Our Knowledge of* Balanophora. I.—The morphological relationships of the host with parasite as well as the manner of origin of the inflorescence has been dealt with.

## Indian Chemical Society.

(Vol. XII, No. 1.)

C. PRASAD AND J. B. JHA: *Potentiometric Estimation of Copper with Sodium Sulphide.* B. K. BANERJEE: *Studies in Acid Anhydrides. Action of Semicarbazides on Anhydrides of Dibasic Acids.* B. K. CHATTERJI AND B. L. VAISH: *A Note on the Determination of the Viscosities of Solutions by the Scarpa Method.* D. N. GHOSH: *On a New Type of Liquid-Liquid Junction.* EDWARD BARNES: *A Note on the Reduction of Selenium Dioxide by Carbon Monoxide.* PULIN BEHARI SARKAR: *On the Tensile Strength of Jute-fibre.* A. R. GHOSH AND B. C. GUHA: *Vitamin C in Indian Food-stuffs.* SALIMUZZAMAN SIDDIQUI AND RAFAT HUSSAIN SIDDIQUI: *The Alkaloids of Rauwolfia Serpentina, Benth. Part II. Studies in the Ajmaline Series.* H. M. MAPARA: *A Note on the Influence of Acidity of Agar on the Liesegang Rings of Lead Chromate and Lead Iodide.* PRIYADARANJAN RAY AND ANIL KUMAR MAZUMDAR: *Hydrazinates of Metallic Thiosulphates.* J. C. GHOSH AND SUKUMAR SEN: *On the Synthesis of Higher Paraffins from Water Gas. The Use of Promoters for Activating Iron-copper Catalyst.* S. M. ABDULLAH: *Addition of Compounds containing Reactive Methylene Group with Phenylringylketone.*

# Reviews.

HANDBUCH DER RADIOLOGIE. Herausgegeben von Prof. Dr. Eric Marx. Band 6: Quanten-mechanik der Matiere und Strahlung. Zweite Auflage der "Theorien der Radiologie." Teil 1: Atome and Elektronen. Pp. 466. Price 43-R.M. (Leipzig: Akademische Verlagsgesellschaft. m.b.H., 1934.)

The first part of this volume is devoted to the quantum mechanics of electrons and atoms and is divided into four chapters dealing respectively with the general theory, excitation and ionisation, electron theory of metals and nuclear physics. The third chapter is the shortest in the book covering about 50 pages and the last chapter is the largest with about 200 pages. While the scope of this Handbook is naturally more limited than the well-known *Handbuch der Physik* of Geiger and Scheel, it possesses all the advantages that a condensed account can give.

*Chapter I*:—This chapter contains all the essentials, from the point of view of a Physicist, of the theoretical portion of quantum mechanics. The knowledge of mathematics assumed on the part of the reader is not very great, such topics like the theory of groups, Hilbert space and matrices not being treated in any detail. A striking omission is an account of quantum statistics which is of the highest importance in special branches, specially the electron theory of metals. This chapter contains an article on mathematical preliminaries which is as devoted entirely to eigenfunctions and is as sweet as it is short. A very welcome feature of this article is the inclusion of Perron's theorem on the nodal points (lines or surfaces) of a wave function. The best part of the chapter is § 8 which gives a masterly exposition of Dirac's theory of the electron in the short space of twelve pages.

*Chapter II*:—This chapter contains a very full account of the experimental results relating to excitation and ionisation. To realise the vast amount of experimental work done in this branch one need only compare this chapter with the well-known book of Franck and Jordan on the excitation of quantum jumps by collision. One would however have wished to see in this chapter a little of the theory of the subject developed succinctly, at least the theory of collisions. Also the account given of thermal effects is rather inadequate. On pp. 223 and 225 the name of Saha is curiously written as "Megh nad Saha". The word "neutron" appears on p. 194, but a perusal of the article in question shows that the authors are using it in the sense of the neutral H-atom. It must however be pointed out that such a comprehensive treatment of the subject collected in one place is perhaps difficult to find elsewhere and this is specially true of photo-ionisation in the Röntgen region and excitation and ionisation of atoms in solid bodies.

*Chapter III*:—The theoretical aspect of the electron theory of metals can be formulated, thanks to the Fermi-Dirac statistics, in such a logical way that it is possible to present a connected account of the subject in a short compass. The distinguished author of this chapter, who is a recognised authority in the field, has made use of this fact in presenting what is easily one of the most readable accounts of the subject. After preliminary theoretical considerations, the Fermi-Dirac statistics is explained and direct applications are made to the passage of electrons through metallic surfaces, optical and X-rays properties of metals and to

conductors, semi-conductors and insulators. The theory of conductivity has one complete section devoted to it wherein all the related phenomena are briefly discussed. The complete omission of supra-conductivity in this chapter can certainly be justified on logical grounds since the extant electron theory of metals does not apply to the interaction of conduction electrons; but at least a mention of the theoretical difficulties and experimental results would have been very welcome indeed. The author departs from the usual practice in calling the Fermi-Dirac statistics merely Fermi-Statistics.

*Chapter IV* :—No branch of physics, not excluding theoretical quantum mechanics, has made and is making such rapid progress as nuclear physics. Experimental results follow one another with lightning rapidity; it thus happens that this chapter written in 1932 has no mention of the positron or the hydrogen isotope. A logical treatment of the subject is also out of question since even Dirac's relativistic theory of the electron is not adequate to treat problems of nuclear structure. Considering these handicaps, it must be said that the author's treatment of the problems of nuclear physics is really an achievement. The account is no mere catalogue of experimental results; quantum mechanics is freely applied in the discussion wherever possible and the difficulties presented clearly. In particular, the inadequacy of Dirac's theory is very well brought forth in the last section of the chapter. This judicious intermingling of experimental and theoretical results throughout the chapter makes it of the highest value to every worker in the subject. The neutron, however, is not given a theoretical background the reason being, perhaps, that Heisenberg's papers on the subject had not yet been published by the time this book went to press. Very full references are given to original papers without any unnecessary attempt at a complete bibliography. A curious error noticed is that in the *Namenverzeichnis*, p. 458 the name of Mott is given as Moté!

B. S. M.

HANDBUCH DER RADIOLOGY. Teil 2: Molekule, Pp. viii + 604. 56 gold marks.

This Handbook has been specially assigned for the quantum mechanics of a molecule. It contains authoritative articles on Band Spectra and Structure of Molecules by R. de L. Kronig, Electrical Properties of Molecules by P. Debye and H. Sack, Rayleigh Scattering and Raman Effect by G. Placzek, Molecular Theory of Magnetism by F. Bloch and Quantum Theory and Homopolar Binding by W. Heitler.

R. de L. Kronig has dealt first with the rotation vibration spectrum of a diatomic molecule, the vibration structure of the electron bands and the multiplicity of the electron states. He has also given the general treatment of a diatomic molecule and the symmetry properties of the energy levels. The explanation of the phenomenon of predissociation has been offered in a separate section. R. de L. Kronig's article is quite simple and clear though he has expressed his ideas in a concise manner.

P. Debye and H. Sack commencing with an account of the Clausius-Mosotti law and the Lorenz-Lorentz law, have presented a clear account of the theory of electrical polarisation and its dependence on temperature followed up by the idea of dipoles in molecules. They have devoted a section on dipole moment and chemical structure of molecules explaining how the vector conception of dipoles are helpful to determine the structure of molecules. Then follows a chapter on dispersion phenomena in gases and liquids. The last chapter in the article deals with the phenomena arising from the electrical asymmetry in molecules such as the Kerr Effect. They have also dealt with the relation between the Kerr constants and the structure of molecules.

G. Placzek has done a very good service to scientists in giving a fairly comprehensive account of the theory of the Rayleigh Scattering and the Raman Effect. First deriving the Rayleigh formula for the scattering of light, he has presented an account of Dirac's theory of the scattering of radiation with a general discussion of the scattering formula and a discussion of the same for freely oriented systems. Next he has presented the foundations of the polarisability theory whose conception explains the origin of the Raman lines. In particular, one needs to know the symmetry properties connected with a given polyatomic molecule to find which of the normal modes of vibration would be active in the Raman Effect and what would be the intensities of the Raman-radiations scattered by a molecule relative to the incident radiation. G. Placzek has therefore devoted a separate section for the symmetry properties and then he deals with the relation between those properties and

the selection rules for the Raman transitions. As some examples, he has given the applications of the theory to some well-known molecules and has suggested that the infrared spectrum and the Raman spectrum of gaseous benzene are of the highest interest. After these simple cases, he has also given a treatment of the splitting up of the Raman lines in $CO_2$, $CS_2$, $CCl_4$ and $NH_3$. Afterwards the theory of the rotational Raman lines has been dealt with reproducing two beautiful photographs of the rotational Raman spectra of nitrogen and ammonia, the first one taken by F. Rasetti and the other taken by E. Amaldi and himself. He closes his article with a section on empirical data connected with the calculation of the polarisability, etc. This article would have been more comprehensive and complete if he had devoted a separate section on the theory of the vibrations of various point systems under internal forces as this subject is very intimately connected with the explanation of the Raman spectra of molecules.

F. Bloch opens his article with the general facts of magnetism with an account of the thermodynamic relations and magneto-caloric effect. Then he gives the theory of the diamagnetism of atoms and molecules both from the classical and the quantum mechanical standpoints, and the diamagnetism of metals. In the section on paramagnetism, he gives the classical Langevin theory, the spin of the electron, the paramagnetism of atoms and molecules and that of the free electrons. In the section on ferromagnetism he deals with its characteristic properties, Weiss's hypothesis of molecular fields and Heisenberg's theory of ferromagnetism and the theory of ferromagnetism at high temperatures. He closes his article by sections on magnetic anisotropy, magnetostriction, "remanenz" and hysteresis.

W. Heitler has treated first with the nature of valence forces with an account of the interaction of two hydrogen atoms and a helium atom and a hydrogen atom. Then the relation between the Periodic classification and the Pauli Principle, the general theory of the interaction of atoms followed up by the details of the perturbation calculus and lastly the theory of the directed valence in polyatomic molecules have been treated in various sections.

Every article in this volume has been written with very great regard to high standard, clarity and conciseness. It is not too much to say that this volume will be exceedingly helpful both to the physicists and the physical chemists.

N. S. N.

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GENERAL ASTRONOMY. By Dr. H. Spencer Jones, F.R.S., Astronomer Royal. (Messrs. Edward Arnold & Co., Ltd., London, W.1.) Pp. 437. Price 12*s.* 6*d.*

The first edition of this interesting work appeared about twelve years ago and attracted considerable attention on account of the clear and lucid presentation it contained of a wide range of subjects in a manner suitable to the layman as well as to the serious student. In the years that have elapsed since then, the progress of astronomy has by no means been slow; the author has taken the opportunity in the second edition to incorporate the recent developments in the science and to completely rewrite some of the chapters that required more than ordinary revision and the result is, we have before us a well-written and comprehensive treatise which will indeed occupy a middle place between the large number of popular text-books and the strictly technical literature of the subject.

The work of revision has been thoroughly carried out and an attempt has been made not only to describe the extensive advances in our knowledge of the sidereal universe, but also to include in the earlier chapters additional matter dealing with the bodies of the solar system derived from recent researches. Some small errors in the former edition appear to have been rectified. A good deal of new material has been introduced in the section on stars which now occupies five chapters of the book. Some of the problems that have been receiving special attention during recent years such as rotation of stars, theory of novæ, galactic rotation and expansion of the Universe are treated in a clear and concise manner. There has been a considerable re-arrangement in the subject-matter according to the trend of modern ideas; the galactic and extra-galactic systems are dealt with in different chapters while the last chapter gives an account of the theories relating to the constitution of stars and their evolution.

A distinctive feature of this book is that mathematics has been carefully excluded; only the elementary formu'æ required for the elucidation of the text are given so that the treatment may be intelligible to all classes of readers. In the limited space

available, the author has succeeded in giving a comprehensive survey of a large and growing subject and there can be little doubt, that in extent and completeness the book forms a compendium of great value. The style is readable and the explanations though brief on some points can be easily understood by the lay reader. To the serious student the book is valuable as providing an authoritative account of the principal features of modern astronomy. It may perhaps be suggested that a bibliography giving a list of references would be useful to those interested who desire to study the subject further.

The illustrations have been carefully selected and it is gratifying to note that with all these improvements the price has been substantially reduced. The treatise may be recommended as a text-book to be used by students taking a course of astronomy in Indian Universities.

T. P. B.

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THERMIONIC EMISSION. By Arnold L. Reiman, pp. xi + 324. (Chapman and Hall, London.) Price 21*s*.

It is doubtful if there is any single invention of the present century which is so useful and universal in application as the Thermionic Valve. It has entered every conceivable industry, it is a powerful tool in the hands of the experimental physicist, and is the very back-bone of Modern Broadcasting, which is providing such wonderful entertainment and education to the people throughout the world. Whether it is the simple triode or the pentode, or even the more complicated heptode that one meets occasionally, it is the simple phenomenon of thermionic emission that is responsible for its section. Ever since the momentous discovery by Thomas Edison in America, and its application to the construction of the first Thermionic Valve by Sir J. A. Flemming in England, it has formed the subject of close study by the practical physicist providing a great bulk of experimental data helpful to the theoretical physicist, particularly in the replacement of the classical, by the quantum statistics in the theory of electrons in metals, and also to the thermionic problem in wave-mechanical theory of the transmission of electrons through potential barriers.

There have been, no doubt, several books on the subject by Richardson and others, most of them fail to render a comprehensive account of the older and the more recent developments from the modern point of view, nor do they provide the many important data made available by new experimental methods and vacuum technique. The book under review fulfils this need. Mr. Rayner being among the research staff in the G. E. C. Laboratories, has first-hand information about the actual conditions of valve manufacture and has something interesting and important to say in the chapter dealing with the emission of electrons from contaminated cathodes, alloys and the oxides of Thorium and Tungsten. The book is roughly divided into four main sections; after a short introduction, survey of the whole field is given in the first chapter. In this is also discussed at some length the more important points like the work function, Richardson's emission formulæ, the Sehottly effect, etc. The next few chapters are perhaps the very cream of the text. The admirably exhaustive discussion of the emission of electrons from clean metals, contaminated metals and oxide cathodes are really very stimulating, and will be of immense interest to the Radio Engineer. A chapter is also devoted to the discussion of the modern theory of electron emission and the emission of ions from electrolytes and from metals.

The inclusion of a few chapters on the experimental technique involved in certain operations would have proved to be most salutary to the interest of those who are practically minded. But even this omission is excusable since the slight digression would have involved a break in the continuity of thought so essential to the proper understanding of the subject.

Finally, the exhaustive bibliography appended at the end of each chapter is of incalculable value to the serious student in making available the original papers on the subject. The get-up of the book is of a high order, the diagrams and the illustrations are apt and help to elucidate the text and the book is sure to commend itself to the physicist and the Radio Engineer in whose shelf it will occupy the place of a handy, up-to-date book of reference.

C. C.

* * *

THE MYSTERIES OF THE ATOM. By H. A. Wilson. (Chapman and Hall, Ltd., London, 1934.) Pp. x + 146. Price 10*s*. 6*d*.

It is one thing to write a text-book or a treatise on a subject meant for students

immediately interested in the particular subject, but quite a different thing to write an account of a supremely intricate and fundamental subject, as for instance, the structure of the atom, so as to make it understandable by readers with very little scientific training. Professor Wilson has set for himself the latter task and in the volume before us an attempt has been made to give a plain account of the modern notions concerning the ultimate particles constituting the universe.

The collapse of the classical laws governing the motion of particles as postulated by Newton, leading to a purely mechanical conception of the universe and the rise of the modern physics concerning the ultimate particles, resulting from the brilliant discoveries of J. J. Thomson, Rutherford, Rœntgen, Heisenberg, Schrœdinger, Dirac and others are treated in non-mathematical language, without entering into technical details. The experiments are described in simple language, the theory and calculations being consigned to the Appendices. Chapters IX and X dealing with the theories of relativity make heavy reading for the uninitiated, and may be omitted. The book fulfils a real want and the lay public who are interested in the modern developments but find in the many modern books only a mathematical treatment of the subject can profitably turn to this book where they will find matter which will amply repay study. The printing and get-up of the book are excellent.

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PHYSICO-CHEMICAL PRACTICAL EXERCISES. By William Norman Rae and Joseph Reilley. (Methuen & Co., Ltd., London, 1934.) Pp. iv + 276. Price 7*s.* 6*d.*

This book which has been brought out by the authors of the now famous work, *Physico-Chemical Methods*, covers the practical course for the B.Sc. Honours. It is comprehensive and thorough and the authors will undoubtedly win the gratitude of many appreciative students who will find in this book solutions for just those difficulties for which they consult the book. The exercises selected are those, which the authors have tried out and which in their experience have proved to be necessary for the students preparing for the Degree examinations. Theoretical principles have been given wherever necessary and the student will find this as also the worked examples very useful. We are confident that the book fulfils a real purpose an are sure that students of chemical sc will find it worth while to add this volume to their libraries.

* * *

LES RADIOCOLLOIDES. By M. Haissi (Hermann et Cie, Paris, 1934.) Pp 9 Francs.

In 1912 Paneth discovered that polo and radium E exhibited colloidal prop in the state of aqueous solutions neutral, feebly acidic or ammoniacal. rium B, an isotope of lead, behaved lik in ammoniacal solutions. The size o particles in the solutions, calculated the velocity of diffusion came out as to $0 \cdot 5 \mu\mu$, and thus explained the invisi of the particles in an ultra-micro The real nature of these particles has ever, been a problem and two diff views have been held, the one that are radio-active compounds in true col state, and the other that they are fo by the adsorption of their ions and mol on the foreign colloids present in the s mediums.

M. Haissinsky, of the Institut du Ra Paris, has sifted out in this monogra the evidences so far advanced for view, and has come to the conclusion the properties of radio colloids are d formation of true colloidal compounds that any foreign substances present only a secondary rôle. There yet remai difficulty that the observed solubilit the hydroxides of lead and bismuth d support the colloidal view. According Haissinsky, however, the solubility mea ments of very slightly soluble salts a little significance, and cannot be di applied to such solutions as the radio col

M. A.

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AN INTRODUCTION TO PRACTICAL ORG CHEMISTRY. By W. A. Waters. (Ed Arnold & Co., Ltd., London, 1934.) x + 92. Price 3*s.* 6*d.*

The book covers an elementary cou practical instruction in organic chem useful for the B.Sc. students. It is di into three parts, Part I dealing wit technique employed in organic chen starts from first principles and will pro be of some use to all those who start course of organic chemistry—student medical colleges, etc. The next part with preparative organic chemistry reactions of groups and the last part wit

elementary principles of qualitative organic analysis.

There are several excellent books on practical organic chemistry and the reviewer finds hardly any purpose served in adding to their list a very elementary book which does not involve any original treatment of the subject. The student will, however, find in it some useful "tips", for his laboratory work.

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CHEMISTRY IN COMMERCE. Volumes I & II. Each Volume issued in eight weekly parts. General Editor: Edward Molloy. Vol. I, pp. 392. Vol. II, pp. 393–775 (George Newnes, Ltd., 1935.) Price 8s. per Volume.

One of the excerpts of the late Mr. S. M. Gluckstein was "A course of chemistry, it seems to me, is in itself an almost commercial education, encouraging as it does, patience, skill in observation,......qualities, all of which are essential in modern commerce," words whose truth has been widely recognised, particularly in the post-war world.

In industrial works, chemists of all grades of equipment are met with—undergraduates, graduates and chemists with research qualifications. Besides these there are those who intend taking up chemistry as a profession; and all of them require to be informed how the works chemist utilises chemistry in controlling the processes and why the chemist has been considered a directing force in industry. The four volumes (to be issued in 32 weekly parts) which Messrs. Newnes have planned, attempt to provide this information, not merely by descriptive text, but also by action photographs.

The volumes are issued under the able editorship of Mr. Edward Molloy, and represent a co-operative effort, the various sections having been contributed by the chief chemists of some of the largest firms in England, who by virtue of their profession, are most qualified to describe how chemical principles are applied in actual practice.

The Editor has set himself an ambitious plan and judging from the volumes before us, a reasonable amount of success has been attained. The work is planned to show how the principles of chemistry find application in industrial processes and as it is made intensively practical, one who is interested in practising chemistry as a profession cannot fail to find in it a wealth of material which will be of immense utility to him. Notes on practical use of instruments like the spectrographs, microscopes, refractometers, polarimeters, viscosimeters, etc., are to be found in the volumes and also short discourses on the determination of moisture content; oxidation and reduction and some of their applications in industry; colour, its determination and measurement; Vitamin A; synthetic dyestuffs; etc. The work is profusely illustrated but one may doubt if all of them are necessary at all. To choose a few at random, figures No. 10 on p. 85, 7 on p. 162, 3 on p. 248, 4 and 5 on p. 287 and 8 on p. 373, do not appear to carry conviction. Fig. 6 on p. 106 and Fig. 14 on p. 110 do not appear to be different as also Figs. 5 on p. 105 and 13 on p. 109. The name of Alfred Nobel is not to be found at all in the first chapter on Founders of Chemistry. But these are all very minor omissions. Viewed as a whole the work contains a wealth of material and deserves to be read by every one interested in Chemistry.

The work must have a special appeal to India where a number of industries are rising and there is a crying need for vigorous chemical control of the processes. There is need for being armoured with every weapon of the modern industrial armoury, if India has to make for herself a place in the Industrial World. In this respect India has to learn a lesson from Japan where the Industrial Works not only employ chemists, but also stimulate the employment of chemists. Let us hope that those interested in the development of industries in India, will keep themselves alive to this fact; when they require information on the scientific requirements of industries, they can turn to these volumes, where, we trust, their requirements will be satisfied.

* * *

THE PHYSIOLOGY OF HUMAN PERSPIRATION. By Yas Kuno, Professor of Physiology, Manchuria Medical College, Mukden. (London, J. and A. Churchill, Ltd., 1934.) Pp. 268 with 38 illustrations. Price 12*s.* 6*d.*

This is a concise but critical exposition of the present state of our knowledge concerning the physiology of human perspiration. The book which is the result of nearly ten years collaboration is rightly dedicated to the colleagues of the author. Much of the matter discussed in the book has been published originally in Japanese; and Prof. Kuno has surveyed the vast literature (both Japanese and Foreign) on the subject and formed a synthesis of his study and

experimental observation. The book comprises eleven Chapters. In the first chapter the morphology and innervation of the sweat glands are described. Chapter II contains a clear account of the methods which Prof. Kuno and his collaborators have employed in the laboratory for the measurement of "perspiration" and a simple but acknowledged yet to be imperfect portable apparatus for use by the Physicians is also described. Chapter III deals with a discussion of the descriptive terms employed and of various factors influencing "sensible" and "insensible" perspiration. Chapter IV contains an account of thermal sweating, a subject on which there appears to be no previous description of authentic nature. This chapter is of considerable importance. In the fifth chapter an interesting account of the features of mental sweating with special reference to the causes of such sweating is given. Further the special characteristics of the perspiration of the palm and the sole on the one hand and the other of the axilla are described. In the sixth chapter the effect of mental stress on the perspiration at varying temperatures is discussed and the question concerning the intrinsic causes of variation in the "palmar sweating" and suppression of general sweating is declared to be obscure at present. The results of a systematic investigation of the features of the sweating due to muscular exercise are embodied in chapter VII and the conclusion that "no process other than the effort necessary for performing muscular exercise can therefore be considered as the cause of this sweating" is reached. The asphyxial conditions during very strenuous muscular exercise would however be an additional cause of the sweating on the general surface of the body. In chapter VIII the physiological necessity for supplying in time water and sodium chloride lost by perspiration is described. The importance of adding minute quantities of salt to the water that workers in over-heated places drink is discussed. Chapter IX is concerned with an account of variations in the ability to perspire due to alterations in the surrounding temperature and to abnormal conditions of the body itself. Individual variations in the ability to perspire with reference to mountain climbing, forced marches of soldiers, etc., are observed. Further the possibility of "training of the sweat glands" is noted. The influence exerted by the osmotic pressure of blood in regulating the sweating process is impressively dealt with, and the injection of hypertonic salt solution has been suggested as worthy of trial in cases of hyperhidrosis. In chapter X a systematic account of the processes involved in the production and inhibition of sweating is offered. Besides noting the variations in the excitability of the individual sweat glands and the periodic discharge of sweat from individual glands, the oxygen consumption of actively secreting glands is dealt with. Chapter XI details the physiological significance of sweating. According to the author, in the human individual the sweat gland of the general body surface plays a very important rôle in temperature regulation, whilst those on the sole and the palm assist by their perpetual secretion in protecting the skin and by sweating facilitate physical work. The sweat from the human axilla disseminates the axillary scent which seems to have a sexual significance. Further, the function of the sweat glands in the elimination of lactic acid during muscular exercise, and the consequent regulation of the H-ion concentration of the blood is discussed. There is an extensive and useful bibliography, and the book is well indexed. The general get-up of the volume is excellent like all other books published by J. and A. Churchill Ltd. The volume deserves a place on the book shelf of every advanced student, teacher and researcher engaged in the study of Physiology.

A. S. R.

## Errata.

* 1935, **3**, 347-348 (*Cf.* The Theory of Liquids).

(1) In every instance *for* the suffix '$m\mu$' *read* ($m.p.$)

* Through oversight the proofs were not sent to the author.

(2) In equations (4), (6) and (8) *for* '$\gamma$' *read* '$\nu$'

(3) In equation (6) and (7) *for* 'M' *read* '$m$'.

(4) Foot-note 2, *for* 477, *read* 497.

(5) In equation (10) *for* $\sigma \frac{m-1}{m.\mu}$ *read* $(\sigma_{m.p})^{m-1}$

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CONTENTS.





# Nutrition Research in India.

THE contributions of Major-General Sir R. McCarrison to our knowledge of nutrition in India form an impressive record of great scientific and practical value, and his retirement from service about the second week of last month has deprived this country of a devoted scientist whose selfless labours have won for him not only public recognition but the personal esteem of all who have come into contact with him. His researches on the thyroid gland in health and disease opened a new and fruitful field of enquiry into the science of nutrition and it is perhaps with this branch of knowledge that Sir Robert McCarrison's name will chiefly be remembered by posterity. He is probably the first medical officer who formulated a synthetic conception of the effects of faulty food on animal organs and tissues in relation to the endocrine regulations of metabolism. As early as 1919, he observed that faulty nutrition led to the degeneration of the cellular activities of the gastro-intestinal tract and a general lowering of the digestive capacity, which, besides diminishing the economic efficiency of man, exposed him to the insidious attacks of disease. This is undoubtedly a significant contribution to our knowledge of the rôle of nutrition in preventive medicine. In fact the latest investigations which have built up our knowledge of nutrition are detailed amplifications of the facts emphasised by Sir Robert McCarrison in his *Studies in Deficiency Diseases* published in 1921; and his other works such as *The Life Line of Thyroid Gland* and *The Thyroid Gland in Health and Disease* form an illuminating chapter in the history of medical research in India.

The medical profession and even the common people recognised from the earliest times the close relationship between food and disease, and numerous aphorisms on the subject testify to the general experience of such intimacy between diet and health. But the science of Dietetics which is comparatively new, is the outcome of the co-operative labours of physiologists, bio-chemists and medical men, and presents problems of vital importance to economists and administrators. For instance, the question of feeding a heterogeneous population in a country like India must necessarily involve detailed investigations of complex issues of an economic and agricultural

character, and as our information on the actual requirements and standard of national diet is rendered more definite and accurate by the progress of research, then it is obvious that such knowledge is bound to influence agricultural policies. The diet of a people affects their welfare no less than it determines the character of their agriculture. In India the choice of food is limited by religious dogmas, and where the ideal of a large section of the people is to suppress the cravings of the flesh as a necessary preparation for the attainment of eternal bliss, considerations of the energy value of different classes of food and the adequate supply of this energy for the maintenance of national well-being and economic efficiency, are subordinated to religious injunctions. Apart from orthodox sentiment, climatic conditions probably exercise an equally great influence on the choice of food by the people, but, generally speaking, there can hardly be any choice among the poorer class of the Indian population. In a tropical climate the resistance capacity of the people is always poor. This is due mainly to insufficiency of food or to wrong selections, and accounts for the prevalence of certain well-known diseases which assume an epidemic form whenever famine and drought fall upon the land.

The problem of food has a deeper significance for Indians than perhaps for any other nation. The people inhabiting certain provinces have been declared unfit for military service and the ultimate cause of the alleged incapacity is as much due to diet as to the meaningless social customs prevalent among them. The progress of foreign education in India is creating an increasingly large community of cultured people whose food, dress and general habits of life differ from those of their grandparents and of their less favoured countrymen. The general impression is that the cultured Indian is less hardy, and therefore prone to certain types of maladies. In the Pre-British days there was intensive indigenous education in India, but there is no record to show that learning undermined the physical efficiency of even the most cultured among the Pandits and their disciples. The introduction of a foreign system of education differing from the cultural traditions of the people must upset the mental and constitutional make-up of its recipients and the reaction is expressed in diminished functional efficiency and capacity for resistance. Severe strain and anxious suspense attend modern educational methods which, while attempting to enrich the mind, generally succeed in undermining the physical vitality of the younger generation. We have not so far devised any means of combating the evil. The remedy does not lie so much in encouraging games and sports as in the provision of a well balanced diet for students in order adequately to equip them to cope with the undue mental exertion which they put forth for meeting satisfactorily the unconscionable standards of public examinations. At present the medical inspection of school pupils and college students is concerned more with the detection of diseases from which they suffer, than in the investigation of the causes which produce them. This is not all. A very large body of ministerial officers and officials is engaged in carrying on the sedentary work of government offices, banks and business firms, and they, like the students, suffer equally from deficiency of diet. The poorer classes have no choice, and generally their food is as bad as bad can be. The problem of feeding India is extremely complicated, and Sir R. McCarrison's researches deal with one aspect of it. We still require an authoritative body of scientific knowledge of the physiological value of the different kinds of food consumed by the Indian people, in relation to their occupations, levels of income, the climatic conditions and the general habits and physical constitution of the indigenous population.

In his farewell address which he gave at Coonoor on 18th March, Sir R. McCarrison pointed out that in his laboratories he kept 1,000 stock rats from which, during the last four years, disease was practically excluded by careful attention to three environmental conditions, cleanliness, comfort and food. Race horses and prize dogs are tended with greater love and care than perhaps even Sir McCarrison's rats. But is there any district where 100 school-going pupils enjoy a fraction of the cleanliness, comfort and perfect food which are bestowed on animals? The tendency of modern competitive civilization is that man will sacrifice everything for the gratification of his vanity, and will almost completely ignore what will promote the health and efficiency of human stock. It seems to us that the warning given by Sir R. McCarrison, "The child is made up of what he eats" is a prophetic utterance, for the nation that neglects its children paves the way for self-extinction.

The main problem of the masses of Indian population is what foods they have to buy in order to obtain the greatest possible nutritive value out of a given amount of money each week. We have a vast body of carefully tested information regarding the nutritive value of the various types of food as well as their physiological value, and the experimental researches of scientists have established standards of nutrition. But the great majority of the people either on account of ignorance or of economic reasons are unable to work these standards into their daily meals. Thus the welfare of the nation which depends basically on how its people eat becomes a matter of chance, instead of being part of a definite economic and social policy of Government. The food requirements of a nation must necessarily lead to the carefully planned adjustment of agriculture, but unfortunately agricultural policy in India is not correlated with the science of nutrition. Obviously all these elements constitute a single great administrative problem and what the people want is a plan which is complete, simple and flexible enough to suit different levels of income. A plan such as we contemplate involves the necessary adjustment of production to consumption by families in the home which is the part that means most for the social welfare and the economic efficiency of the working classes. The cultivator therefore has to produce the right kinds and the appropriate quantities of food. On the other hand the consumers must have a definite knowledge of the facts about the diet in relation to health, the standards of food nutrition and the fundamental principles guiding the selection of a diet that promotes health and safeguards against diseases. Every individual is entitled to have an optimum diet though not to a Dukedom. We are thus confronted with the problem of the need and possibility of building up a physically better, healthier and more vigorous population in India by means of better nutrition. The first step in the solution of this question is the consideration of costs, and we have therefore to prepare dietetic patterns at different levels of nutritive content and cost. What we really want is clear and usable statements of the foods to buy and the quantities needed for every class of people suited to their incomes. The scientists have to deal not with the food which an ample purse can buy, but with that for which people have to rake and scrape and count every pie they spend and then do not have enough to go around.

The common practice in India is to cook food containing strong organic acids and alkaloids in vessels made of brass, copper, bell-metal, iron, tin and aluminium at very high temperatures, and cooked food is also stored in these metallic vessels for very long periods of time. The Biochemistry Department of the Indian Institute of Science has been conducting a series of interesting experiments on the effects of food cooked in the various kinds of metallic vessels on the general health and biological efficiency of rats, and the results that have so far been obtained tend to establish that foods cooked in earthen pots promote and preserve the health of rats, while those fed on food prepared in metallic vessels develop a predisposition to ill-health and premature senility. These researches are of the greatest significance to the general public and one of the reasons for the poor physique of the richer and the middle classes of Indian population may be the slow and insidious contamination of food by metals. The prejudice in favour of metallic vessels is too deep-rooted to be removed by scientific researches, and further, this problem is so intimately connected with important metal industries, that sudden discontinuance of all metallic utensils on a wide scale is bound to produce economic dislocation, unless some other lucrative and cheap industry can be substituted in their place.

It may be that nobody in India actually starves in the broad sense of the term, but many Indians live and must live on diets that are an outrage to the known needs of the human organism. The very fact that this basic thing,—adequate and proper food,—is not now within the reach of a large section of our people is a reproach to our social and economic organisation. Nutrition experts have to devise a dietetic plan for poor people which would enable them to secure the full nutritive value out of the foods which they can buy, and which will keep them in health and reasonable comfort. Starting with such a plan, it would be easy to frame other patterns suitable to the different social strata with varying incomes; but the fundamental point is that social justice and commonsense emphasise that every individual is entitled to work, to earn his wages and to eat in order that he might have the strength to gain his bread on the morrow. The case of the school-children

and college students is perplexing. We have no reliable information in regard to the influence of the mental strain and worries on their physical constitution nor do we possess any on the adequacy or otherwise of the food they consume. The general complaint that University education tends to lower the physique of the Indian graduates and that a highly educated person has a diminished capacity of resistance presents an important problem for investigation. Another equally important question for enquiry is why certain races in India are considered unfit for military service. In cases of emergency the State ought to be able to mobilise the whole man-power of the country for defence, and in times of peace, every person must have sufficient strength to protect the honour of his family and his property. Faulty food and the insufficient supply of perfect food must account, at least partly, for the poor vitality and physical strength of this particular group of people. If the whole nation is to be fit and vigorous, then it is clear that food is the starting point.

The question of feeding India for national efficiency is sufficiently important to warrant the creation of certain new departments such as the Bureau of Food Economics and the Agricultural Adjustment Board which would have to work in closer collaboration with the Nutrition Research Laboratories at Coonoor and with the Provincial Agricultural Departments. The first step is to work out a set of figures showing the amount of land that would have to be devoted to various food crops for each of the different dietary plants, assuming that they will be universally used by the Indian population. These figures will naturally include not only crops used directly for human food but also crops necessary to feed the required dairy and work animals. A close relationship has thus to be established between dietary habits and agricultural practice.

Education must go hand in hand with the spread of sound knowledge of diet so as to ensure that every poor family in India acquires enough information to make a correct selection of food and improve food habits. For this purpose the vernacular newspapers and magazines should constantly emphasise the importance of perfect diet and its relation to national efficiency; perhaps the radio will be of immense service in improving Indian dietary as a whole. In their eagerness to be well and to be at their best, people will readily accept misleading information and one of the chief concerns of the new departments suggested, will be the raising of the dietary standards as one of effective propaganda. It is made the easier by the fact that good diet or even optimum diet is not out of line with the average Indian food habits, even though the emphasis may be different. In India, the food of the poor man has to be investigated as carefully as milk has been investigated, and this new work has to define accurately the needs of the poor for various food elements, determine their functions and uses in the body, and perhaps discover, if possible, new elements. This is the only way in which we can plan diets intelligently, weighing both economic and nutritive values. The difference between the diet of the poor man and of the rich man may after all be one of cost, but scientifically there is a unity of interest, *viz.*, the need for well being. This seems to be the cardinal truth of the body of man as well as of the society of men. The wise management of a family may be an individual's concern, but the maintenance of the national well being is absolutely the task of government.

## Research on Bananas.

AT the instance of the Government of Madras a scheme for the improvement of the Banana has been sanctioned by the Imperial Council of Agricultural Research, Delhi, at a cost of Rs. 74,000, spread over 5 years, in the first instance.

The Banana Research Station will be located at Coimbatore where considerable preliminary work has been done.

The problems of investigation will be the survey and classification of varieties, study of the keeping quality of the fruit, standardisation of the best methods of cultivation, conducting of manurial experiments both for quality and quantity, selection of pure lines involving new and desirable types, methods of transport, study of the banana diseases and their control, preparation of banana products like flour, "fig", jam, preserve, etc.

# A Note on *Blaise Pascal* (1623-1662).

## A Forerunner of Leibnitz and Newton in the Discovery of the Calculus.

By D. Ferroli, S.J., D.Sc.

In 1628 the Jesuit Mersenne propounded a question to Mathematicians, *i.e.*, the finding of the area of the cycloid. The problem was the object of protracted researches on the part of many Mathematicians. Towards the middle of the century *Blaise Pascal*, already famous for his physical discoveries, set himself the task of combating atheists. One day, as his niece Marguerite Périer tells us, he suffered from a violent toothache. To find relief from physical pain he concentrated his attention on Fr. Mersenne's problem. He solved it, and incidentally found the Infinitesimal Calculus.

He pondered long over his discoveries, and in June 1658, in a letter addressed to all geometers of repute, under the *nom de plume* Amos Dettonville, he asked them to (*a*) find the area of a segment of a cycloid, (*b*) its C.G., (*c*) the volume of the solids it generates in revolving round its axis and round its base, (*d*) their centres of gravity, as well as the centres of gravity of the halves of the said volumes supposed to be intersected by a plane through their axis.

Later on he discovered that the problems had been solved by Roberval. He withdrew them, and decided that a competition should be held only on the problems under (*d*). However, in his "*Histoire de la Roulette*" and in his "*Recit de l' examen et du jugement des écrits envoyés pour le prix*" he forgets that Amos Dettonville (*i.e.*, himself) had propounded also the problems under (*a*), (*b*) and (*c*), thus occasioning long misunderstandings with his rivals. He wrote then that he had found for himself "methods for determining the size and centres of gravity of solids, of plane and curved surfaces, and of curved lines which he believed would apply almost to everything".

In a letter to M. de Sluse of December 1658 Pascal again speaks at some length of "the wonders of the new analysis," of which he formulated some principles, though he did not endow it with proper symbols. However, the mathematical thought of the times was definitely turning towards the "new analysis". Archimedes' "*Method of Exhaustions*" was well known, and so was Cavalieri's "*Method of Indivisibles*" as can be seen in the works of Napier, in Fermat, in Wallis and others. According to Chevalier, Pascal's most recent biographer, he was the first to determine the sum to infinity of a series of infinitely small quantities, though, according to other historians, the priority must be given to others. In the "*Traité des sinus du quart du cercle*" Pascal deals with the so-called "*characteristic triangle*", which is a trilinear figure "infinitesimally small", contained between two straight lines at right angles to each other, and an arc of a circle, limited by them.

Now Leibnitz owns that he arrived at the idea of a *differential* in studying the "characteristic triangle". Also the formulæ of the Calculus are discernible in the annotations made by Leibnitz to Pascal's work.

We are all acquainted with Pascal's *Arithmetical Triangle.*

$$\begin{array}{llllll} 1 \\ 1 & 1 \\ 1 & 2 & 1 \\ 1 & 3 & 3 & 1 \\ 1 & 4 & 6 & 4 & 1 \\ 1 & 5 & 10 & 10 & 5 & 1 \quad \text{etc.} \end{array}$$

Perhaps the inventor was not Pascal, but Tartaglia. At any rate, Pascal drew from the triangle the determination of *numerical orders*, the calculation of *combinations* and *permutations*, the beginnings of the theory of *probabilities*, the co-efficients of Newton's *binomial theorem*, the first principles of *statistical science*, and the "*Potestatum numericarum Summa*". It was from this that he set out the main rules of integration.

Thus the formula

$$\int_0^x x^p dx = \frac{x^{p+1}}{p+1}$$

is enunciated by Pascal as follows: "The sum of the same powers of a certain number of lines is to the power immediately above the highest of them as the unit is to the index of this same power"—*i.e.*, in modern notation,

$$\frac{\int_0^x x^p dx}{x^{p+1}} = \frac{1}{p+1}.$$

From this he could easily estimate parabolic areas. In fact, to choose a simple example:

$$\int_0^1 x^2 dx = \frac{x^3}{3} = \frac{1}{3}.$$

Pascal's method is more elaborate.

In estimating the area contained between the axis of $x$, the ordinate parallel to $Oy$, when $x = 1$ and the curve $y = x^2$, he divides the abscissa into $n$ equal intervals between 0 and 1, and he obtains a series of rectangles, whose horizontal sides are all equal to $\frac{1}{n}$, and whose vertical sides are $\left(\frac{1}{n}\right)^2, \left(\frac{2}{n}\right)^2, \left(\frac{3}{n}\right)^2 \ldots$ The sum of the rectangular areas is

$$\frac{1}{n}\left\{\left(\frac{1}{n}\right)^2 + \left(\frac{2}{n}\right)^2 + \cdots + \left(\frac{n}{n}\right)^2\right\} =$$

$$\frac{1^2+2^2+\cdots+n^2}{n^3} = \frac{\left(1+\frac{1}{n}\right)\left(2+\frac{1}{n}\right)}{6}.$$

When $n$ is extremely large this is practically equal to $\frac{1}{3}$. It is rigorously equal to $\frac{1}{3}$ for $n = \infty$.

Pascal's quick mind noticed that the result is not altered if *one*, or a *finite number* of rectangles is omitted. In fact

$$\operatorname*{Lt}_{n\to\infty} \frac{1^2+2^2+\cdots+n^2}{n^3} = \operatorname*{Lt}_{n\to\infty} \frac{1^2+2^2+\cdots+(n-p)^2}{n^3}$$

for $p$ finite.

Hence his fundamental principle that "the sum of an infinitely great number of infinitely small quantities may have a finite value, while the sum of a finite number of infinitely small quantities is always infinitely small, and therefore can be neglected with respect to the finite magnitude under consideration". Of course, the sum can be neglected because it is of a lower order of infinity.

The principle—with which modern mathematics have made us quite familiar—is enunciated in the treatise "*Potestatum numericarum Summa*", which was composed in 1654. Pascal says there: "A continuous magnitude of a given order is not increased if there be added to it, up to any required number, magnitudes of a lower order of infinity. Thus points add nothing to lines, or lines to surfaces, or surfaces to solids, or roots do not count in relation to squares, squares in relation to cubes; so that magnitudes of a lower order should be neglected as of no account."

From this mathematical principle Pascal rose to the following stupendous consideration: "All the bodies in the Universe cannot give rise to even the least of minds; and with all that minds can produce, they can never give rise to the least impulse of charity." This is clear, for bodies, minds and charity belong, as it were, to different orders of infinity—the material, the spiritual, the supernatural—, and one is as nothing when compared with the other.

Leibnitz pondered deeply on these thoughts, and in an unpublished fragment, where he transcribed Pascal's notions of twofold [and manifold] infinities, he added: "What Pascal has just said about the twofold infinity is only an introduction to my system [of the infinitesimal Calculus]".*

It is, perhaps, worth while transcribing here Pascal's famous thought—one of the most complete—where he discourses and meditates on the infinitely great and the infinitely small. "Let man contemplate the whole realm of nature in its full and exalted majesty, turning his eyes away from the base objects that surround him on all sides. Let him lift his glance to this dazzling light, placed like a lamp to illumine the universe to all eternity; let the earth appear to him but as a point in the vast circle described by this luminary, and let him pause to wonder at the fact that this vast circle itself is but a tiny point compared to that described by the stars revolving in the firmament. But if man's view be arrested there, let his imagination pass beyond this point, and it will exhaust its powers of conception, before nature has exhausted its supply of concepts. This whole visible world is but a speck on the broad bosom of nature. No image can do it justice, and however we may enlarge our conceptions beyond all imaginable space we create but atoms in comparison with the actual realities. It is a sphere, whose centre is everywhere, and its circumference nowhere. It is, in short, the greatest characteristic available to sense of the almighty power of God that our imagination should lose itself in the thought.

"Then, returning to himself, let man consider what he is in comparison with all this expanse of being; let him regard himself as lost in this remote province of nature, and from the little cell wherein he has his

* *Cf.* Baruzzi, *Leibnitz et l'organisations religiene de la terre*, pp. 224-30.

abode, the universe, let him learn to estimate aright the earth, its kingdoms, its cities and himself. What is man in the infinite?

"But to show him another marvel, no less astonishing, let him examine the minutest things he knows. Let him consider a mite and note the tiny body composed of parts incomparably more minute; the limbs with joints, the veins in the limbs, blood in the veins, humours in the blood, drops in the humours, and vapours in the drops. Let him again divide these parts, exhausting his powers of imagination, and he may think he has arrived at the most extreme diminutive in nature. Then I will open before him a new abyss. I will depict for him not only the visible universe, but all the immensity of nature imaginable in the enclosing envelope of this minute atom. Let him see therein an infinity of universes, each with its firmament, planets and earth in the same proportion as in the visible world. In each earth animals, down to the midget existences that show him all that he has already seen in the first. However many he may see he will find in all the same unending, unresting purpose, and he will lose himself in all these marvels, as wonderful in their minuteness as the others in their immensity, for who will not be amazed to realise that our human body just now perceived to be but an imperceptible atom in an insignificant planet of the universe, now becomes a colossus, a world, a vast whole with regard to the nothingness into which we cannot penetrate?

"Whoever sees himself in this way will be terrified of himself, and, considering how he is upheld in the material substance nature has given him between the two abysses of the infinite and nothing, he will tremble at the sight of such marvels; and I think that as his curiosity changes into wonder he will be more disposed to contemplate them in silence than to presume to investigate them.

"For after all, what is man in nature? A nothing compared with the infinite; a whole with regard to nothing, a mean between nothing and everything. Infinitely far removed as he is from understanding either extreme, to him the end of all things and their beginnings are hidden in a baffling, impenetrable mystery; he can see neither the nothingness whence he was taken, nor the infinity in which he is engulfed."

## The Theory of Valency: Development and Problems.

By R. Samuel, Dr.Phil. (Goettingen),
*Nizam Professor of Physics, Muslim University, Aligarh.*

During the last century chemistry built up the system of molecular structures as we know it to-day. Firstly and mainly it is characterised by the phenomenon of "saturation of valency". The chemical forces of the atoms were described by valency bonds which represented the number of valencies of each atom, two of these bonds were able to combine two atoms in chemical union, and molecules with unsaturated valencies existed only under abnormal conditions as in free radicals or in many unsaturated molecules such as BeF, BeH, AlH, CH, etc., which the physicist observes in the electric arc or in the discharge tube. It was of course necessary to assume that many atoms possessed different valency numbers but modern atomic physics has furnished such a simple and obvious explanation of this phenomenon, that we do not see any difficulty in this second assumption to-day. The simple rules worked out by Chemistry during the last century meet the requirements of all primary molecules.

Chemistry, however, was unable to give any explanation of the mechanism of chemical combination in either case, and had to be content to introduce names only for the unexplained chemical forces, such as affinity, forces of valency and so on, which could not be identified with those physical forces known at the time. Whereas Chemistry gave us a full answer to the question, *which* chemical union occurs if atoms approach each other, the question *why* it occurs and why it occurs just in this way could only be successfully taken up a century later by modern atomic physics. From the moment onwards when Bohr's theory of the structure of atoms made its appearance in 1913, it was clear that it could be only a question of time until the explanations of the problems would be found. The development took place in two steps. During the reign of the pre-wavemechanical quantum theory of the atom, heteropolar molecules could be explained and many of their properties quantitatively calculated and also some preliminary

models of homopolar molecular structures could be developed. Wave-mechanics opened the second epoch by explaining and (in some cases) directly calculating the forces which keep the neutral atoms of a homopolar molecule together and we may say that we have already advanced to a rather complete physical understanding of the principles involved in the chemical behaviour of atoms and molecules, even if many questions concerning details cannot fully be answered in the present moment.

In 1916 Kossel and Lewis simultaneously and independently put forward two theories, closely related to each other. The starting point of Kossel[1] was, that the number of outside electrons of free ions as they exist in solutions is identical with that of the nearest rare gas. Thus in sodium chloride the sodium atom has lost its eleventh electron and the positive sodium ion remains with the configuration of neon whereas the chlorine ion has gained this electron and has raised its electronic configuration to that of argon, which follows one step in the periodic system. Representing the outside electrons in the usual way by little dots (leaving the inner shells aside) we may represent this process by the following formula:

$$\mathrm{Na}\cdot + .\underset{..}{\overset{..}{\mathrm{Cl}}}: = [\mathrm{Na}]^{+}\ [:\underset{..}{\overset{..}{\mathrm{Cl}}}:]^{-}$$

He therefore assumes that the electronic configuration of the rare gases is not only inert in a chemical sense but that also a peculiar physical stability is due to it, so much so that in the process of adding an electron to the neutral chlorine atom in excess of its nuclear charge, energy is liberated. This conception serves very well the demands of the heteropolar molecules which are made up of ions. The forces of the electrovalent link are therefore successfully identified with electrostatic forces between ions. Kossel uses it also in explaining homopolar linkages; it is, however, only fair to mention, that he considered this always as a first approximation only and hoped to overcome the obvious difficulties by considering the ions not as rigid balls but as capable of mutual polarisation.[2] This idea, so to speak the next approximation of Kossel's theory, was extended by Fajans and his collaborators. In the meantime, however, Kossel was able to explain certain details of chemical behaviour without a special model of the homopolar linkage; thus the *maximal* valency number of nitrogen or phosphorus is 3 in combination with positive partners as in $PH_3$, $NH_3$, AlN, etc., because three electrons are missing for the completion of the configuration of the *following* rare gas, but it is 5 in combination with negative partners like in $N_2O_5$ or $PCl_5$ because these atoms possess 5 electrons more than the *preceding* rare gas. This agreement between valency number and the number of outside electrons shows that certain features even of the application of Kossel's theory to homopolar linkage cannot be overlooked in a definite formulation of a theory of valency.

Lewis[3] also started from the apparent stability of the eight-electron configuration of the higher rare gases. The main feature of the theory is, however, a special conception of the homopolar linkage which made it extremely useful in the hands of the organic chemist. From the fact, that nearly all stable homopolar molecules possess an even number of electrons, he concluded that a *pair* of electrons is responsible for each homopolar bond, without actual transfer of charge. The combination of two hydrogen atoms was written as follows:—

$$\mathrm{H}. + .\mathrm{H} = \mathrm{H}:\mathrm{H}$$

meaning, that in the molecule both electrons now are under the influence of the field of both nuclei. By this process of "sharing" the electrons, the system of two hydrogen atoms becomes more stable. Lewis believed magnetic forces to be the cause of the electron sharing. He could not know that quantum-mechanics would later reveal a then unknown force by which the "covalent" bond, as it was later called by Langmuir, is produced; but even this was not so far from the truth, since we know to-day that the spin of the electron plays a great part in chemical combination. The model of the hydrogen molecule, however, taken as such, was fully confirmed and substantiated by wave-mechanics.

In Lewis' model of the hydrogen molecule the electrons are redistributed in such a way, that each nucleus is related now to 2 electrons, that is, the number of electrons in the next inert gas, *i.e.*, helium. The combination

[1] W. Kossel, *Ann. d. Physik*, 1916, **49**, 229. *Cf.* the monograph: "Valenzkræfte und Roentgenspektren" (Berlin, 1921).

[2] *Cf.* the discussion in *Zs. Elektrochem.*, Report annual meeting Bunsen Soc., 1928, pp. 24 and 60.

[3] G. N. Lewis, *J. Amer. Chem. Soc.*, 1916, **38**, 762; *Proc. Not. Ac. Amer.*, 1916, **2**, 586. "Valence and the structure of atoms and molecules," 1923.

of four chlorine atoms with carbon to carbon tetrachloride takes place according to the formula:

$$\cdot\dot{\underset{\cdot}{C}}\cdot + 4\,\cdot\ddot{\underset{\cdot\cdot}{Cl}}: \;\rightarrow\; :\ddot{\underset{\cdot\cdot}{Cl}}:\overset{:\ddot{Cl}:}{\underset{:\underset{\cdot\cdot}{Cl}:}{C}}:\ddot{\underset{\cdot\cdot}{Cl}}:$$

Thus each nucleus is related to 8 electrons, that is, the number of the outside electrons, in the higher rare gases. He assumed, therefore, that the electrons tend also to form octet configurations in covalent molecules. Thus Lewis' theory contains two postulates: (1) the Duplet Rule which makes the formation of a pair of electrons responsible for each individual bond, and (2) the Octet Theory which assumes the tendency of octet formation. It should be clearly borne in mind, that these two postulates are independent of each other. This is important, because they are also completely inconsistent with each other. It is true that the system of organic chemistry can conveniently be described by the Octet Theory, but this is the automatic result of the prevailing tetravalency of carbon. If each chemical bond is represented by a pair of electrons, then each tetravalent atom will be surrounded by eight electrons in the molecule simply because four times two is eight. Organic chemistry deals only with a few atoms whose varying combination produces more than a hundred thousand molecules. In the periodic table we know, however, to day 92 atoms, many of which possess different states of valency. Thus the tetravalent carbon atom is one only out of about two hundred cases of valency and every one of them is equally important; if we want to build up a theory of valency we have just to consider inorganic chemistry which represents a greater multiplicity and variety of chemical combinations. In the moment we leave alone the fourth group and the few cases, where the number of positive and negative valencies is equal and consider any other group of the periodic table, we see that either the Duplet Rule or the Octet Theory has to be abolished. Either the Octet Rule is strictly maintained, then the electrons have to be counted in such a way that their number when surrounding the central atom is increased on the left hand side of carbon in the periodic table and is decreased on its right hand side. This is done by introducing devices such as the semipolar double bond and the singlet linkage. Or the Duplet Rule is strictly maintained, then the number of surrounding electrons is always double the number of valencies, *i.e.*, mostly double the number of *p*-electrons or of *s* + *p*-electrons of the central atom and the significance of the Octet vanishes. Indeed from here onwards two different schools of thought have been developed on two different lines: the first theory is intimately connected with the names of Langmuir, Lowry, Prideaux, Sidgwick, Sugden a.o.,[4] the second was mainly developed by Grimm and Sommerfeld.[5] Incidentally Lewis himself attributed greater importance to the electron-pair-bond theory of linkage. Thus he states[6] "The striking prevalence of molecules in which each atom has its full quota of four electron pairs in the outermost shell has led Langmuir to attempt to make the Octet Rule absolute, and he even proposes an arithmetical equation to determine, in accordance with this rule, whether a given formula represents a possible chemical substance. I believe that in his enthusiasm for this idea he has been led into error, and that in calling the new theory the "Octet Theory" he over-emphasises what is after all but one feature of the new theory of valency. The rule of eight, in spite of its great importance, is less fundamental than the rule of two, which calls attention to the tendency for electrons to form pairs. The electron pair especially when it is held conjointly by two atoms, and thus constitutes the chemical bond, is the essential element in chemical structure."

Thus the pre-wave-mechanical, naive Quantum Theory gave us a complete understanding of the heteropolar chemical combination (taking the existence of electron affinity for granted) but was not able to explain that mutual interaction of electrons on which the electron affinity itself depends, and the homopolar linkage. Therefore, it was possible to interpret this phenomenon in different ways and two different schools of thought have been developed. One of them maintains the existence of particular stable electronic configurations around each atom

[4] *Cf.* Sidgwick, *Electronic Theory of Valency* (London, 1927).

[5] *Zs. f. Phys.*, 1926, **36**, 36. *Cf.* Grimm's article in *Handb. d. Phys.*, **24**. Lessheim and Samuel: "Die Valenzzahl, etc." (Berlin, 1927).

[6] "Valence etc." Chapter VIII. *Cf. J. Chem. Phys.*, 1933, **1**, 23.

(Octet Theory) but has to resort to different varieties of non-electro-statical linkage. The other one is a uniform theory which maintains the close relation between the number of valencies of an atom and the number of its electrons in its various outside groups and sub-groups and obtains stability in all cases in which the electrons of the central atom not taking part in the linkage form completed groups and sub-groups. We shall see later, that this difference of opinion leads even to-day to two different interpretations of the wave-mechanical treatment of the homopolar molecule, either being logical and self-contained, in such a way that we can decide between them only by comparing their results with experimental evidence.

If we are now going to consider the results achieved by wave-mechanics in recent years, we encounter the same difficulty with which every one who speaks or writes about quantum mechanics is faced. If we are coming to atomic dimensions, matter behaves unexpectedly different from its behaviour known to every one from the experience of daily life. We understand this behaviour in this sense, that we are able to describe it by valid mathematical formulæ and therefore wave-mechanics was able to explain covalent linkage between two atoms. If we take up, however, our leading question again and ask with which physical forces we have to identify now those "forces of valency," we are still at a loss to answer this question. It is—as a matter of principle—not possible to describe this behaviour by an analogy or a model based on daily experience or even in the language which was formed during hundred thousands of years by this experience of the macroscopic world and which, therefore, does not offer us either words or conceptions for such a description. In wave-mechanics, the Hamilton-Jacobi's equation of classical dynamics is replaced by a different equation, the so-called Schrœdinger wave equation. Because the effects in the atomistic world are different from those in the microscopic world, they can be expressed only by a different method of calculating, which we call wave-mechanics and for which this equation is the foundation. In particular, covalent linkage is not due to an attraction of the atoms according to Coulomb's law but to a purely wave-mechanical effect which has no classical analogue but is somewhat similar to the classical resonance phenomenon. If the system of two atoms is degenerated in such a manner that its energy value can be represented in two different ways—*e.g.*, by the exchange of electrons which are identical and whose exchange is therefore without an influence on the energy of the total system—this degeneracy is eliminated so that the common energy value is replaced by two different ones, one higher and one lower than it. The $H_2$ molecule, *e.g.*, consists of two nuclei ($a$) and ($b$) and two electrons (1) and (2). Electron (1) may be with nucleus ($a$) and electron (2) with nucleus ($b$); the system may have an energy E. The electrons (1) and (2) are indistinguishable, so electron (1) may also be with nucleus ($b$) and electron (2) with nucleus ($a$) and the energy of the system will have the same value E. Wave-mechanics says then that the actual energy value is not E, but there are two possibilities one value lower than E, another higher.[7] The lower one is even lower than the sum of the energies of the two separated atoms and leads therefore to chemical union and the liberation of this energy difference appears as heat of formation. The higher one leads to an elastic collision of the two atoms. The non-elastic impact and chemical union occurs, when the two electrons possess anti-parallel spin vectors, the electrons then going into the same quantum group of the molecule, and the elastic impact occurs in the case of parallel spin vectors. The wave-function of the $H_2$ molecule, corresponding to the lower energy value, shows a finite probability for the electron of the one atom to be also with the other one and we may interpret this as the analytical representation of Lewis' process of sharing. If on the other hand the same calculation is applied to two unexcited helium atoms, each possessing already two equivalent electrons in the same quantum group, *i.e.*, with counter-balanced spin, no splitting of the energy value occurs and chemical union is not possible. It can take place only between excited He atoms in which the closed group of electrons is fissured and indeed such $He_2$ molecules formed by excited atoms are spectroscopically known to exist in the electric discharge tube. A closed quantum group always renders the atom chemically inert.

The wave-mechanical calculation, the results of which have been just described, was first given by Heitler and London. Since

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[7] W. Heitler and F. London, *Zs. f. Phys.*, 1927, **44**, 455.

the system of two hydrogen atoms contains four particles, the Schroedinger equation cannot be solved directly but has to be approximated. In the following table we compare the observed constants of the $H_2$ molecule with the results of the calculation of Hylleraas,[8] who continued the wave mechanical treatment with higher approximations.

| | Energy of dissociation in electron volts (1 e.v. = 23 k cal/mol.) | Internuclear distance in Angstrom units ($10^{-8}$ cm.) | Moment of inertia in g. cm.$^2$ |
|---|---|---|---|
| Calculated | 4·37 | 0·72 | 4·28 $10^{-41}$ |
| Observed | 4·4 | 0·76 | 4·72 × $10^{-41}$ |

Wave-mechanically the molecule is described by its wave-function. The method of Heitler and London consists in constructing the wave-function of the molecule by combining those of the separated atoms. Another way of doing it is to consider only the wave functions of the valency electrons of the separated atoms and to build up that of the molecule from them. This method was successfully used by Slater and Pauling[9] in explaining the valency angle in such molecules as $H_2O$, in which the valency electrons of the central atom are *p* electrons.

Both these methods commence with the system of the separated atoms, which are thought to approach each other, their mutual interaction gradually increasing. There is, however, a third method, developed mainly by Herzberg, Hund, Lennard Jones and Mulliken,[10] which considers the already combined atoms, *i.e.*, the completed molecule from the very beginning and which is called the method of molecular orbitals, an orbital being a quantum group of the molecule. The nuclei are thought to be fixed at a particular internuclear distance together with their cores of inner electrons which do not take part in the chemical linkage, the so called "atomic orbitals". The outside electrons are added one by one to this skeleton, filling up the "molecular orbitals". Thus the wave function of the molecule as a whole is constructed by combining those of the single electrons, which from the very beginning are under the influence of both the nuclei.

Ultimately of course all the e methods are bound to merge and it should not matter, if the wave function of the molecule is approximated by separated atoms, decreasing their distance, or by electrons brought in the field of the two nuclei which have already the proper internuclear distance prevailing in the molecule. We are, however, not able to calculate sufficiently high approximations and therefore the results may vary, each method giving a different approximation of the same true wave function of the molecule. In general we may say that the results of the first two methods, which commence with the separated system, describe better the conditions in the molecule at larger distances of the nuclei, whereas the third method naturally gives better results at lesser distances. Since, however, actual calculation is possible only in the simplest cases, and has to be replaced by generalisation in heavier, poly electronic molecules, there remains a certain discretion of interpretation, which leads to different theories of valency.

It is obvious that the first and second methods of mathematical treatment lead to an electron pair bond theory of valency; in polyatomic molecules these pairs of electrons which represent the chemical bond are localised between two nuclei. Only the third method presents different ways of interpretation as to a theory of valency. Chemical linkage is always due to a degeneracy, as described above. In those simple cases, in which actual wave mechanical calculation is possible, there exist, however, two possibilities. The linkage, *i.e.*, of $H_2$ may be ascribed either to the degeneracy produced by the equality of the two electrons or to that produced by the equality of the protons. Hund has shown that the latter one is preserved to a certain extent, even when the nuclear fields are not exactly but almost equal. Assuming that chemical linkage is always due to the strict or approximated equality of the *nuclear fields*, we derive a theory of valency in which already the *single* electron produces a bonding effect; if, however, the generalisation is done on the lines, that the equality of the *electrons* produces the degeneracy necessary for chemical linkage, we are led to a *pair bond* theory of valency. In other words, when constructing the wave function of the molecule by introducing the electrons one by one into the

[8] E. A. Hylleraas, *Zs f. Phys.*, 1931, **71**, 739.

[9] J. C. Slater, *Phys. Rev.*, 1931, **37**, 481; **38**, 328, 1109; 1932, **41**, 255: L. Pauling, *Phys. Rev.*, 1932, **40**, 891; *J. A. C. S.*, 1932, **53**, 1367, 3225.

[10] G. Herzberg: *Zs. f. Phys.*, 1929, **57**, 601. F. Hund: *Zs. f. Phys.* 1931, **73**, 1, 565; **74**, 1, 429. J. E. Lennard-Jones: *Trans. Farad. Soc.*, 1929, **25**, 668; 1934, **30**, 70; R. S. Mulliken: *Phys. Rev.*, 1932, **40**, 55; **41**, 49, 759; 1933, **43**, 279 a.o.

combined field of the two nuclei, we may either consider them as independent, more or less neglecting their mutual interaction, or we may assume that such an approximation is insufficient for a theory of valency and that the mutual interaction is just the essential point for it. There is no doubt that both effects are always present but which of them prevails normally cannot be decided by the mathematical treatment itself. In any case, whether the wave-mechanical method of molecular orbitals is interpreted as a single electron bond theory of valency or as an electron pair bond theory, a postulate is introduced and the decision has therefore to be arrived at by comparing the results of both views with empirical facts.

It is already possible to calculate some of the important features of a molecule by treating the electrons as independent. The method of molecular orbitals owes its success just to this, that the term system and the electronic configuration of the completed molecule can be derived already in an approximation in which the interaction of the molecules has not to be considered. The results, obtained in this way, have led some authors to believe that the question of chemical linkage may also be reduced to the bonding effect of a single electron in degenerated nuclear fields. This view is supported by the existence of the molecule ion $H_2^+$ which contradicts any pair bond theory of valency, because only one electron is left and here the linkage is certainly due to the strict degeneracy of the nuclear fields. In poly-atomic molecules the independent electrons are "non-localised" and do not belong to any particular nucleus, and this gives an opportunity to translate the Octet Theory of Chemistry into wave-mechanical language. It requires, however, the additional hypothesis, that the vastly different fields of say, $C^{2+}$ and $O^{4+}$ in CO or $Ca^{2+}$ and $F^{5+}$ in CaF etc. are almost degenerated.

As soon, however, as the nuclei are not protons, just those molecules exist which possess a bonding pair of electrons, as $Li_2$, LiH, BeH, $(BeH)^+$, but those with one electron only cannot be found even spectroscopically like $(Li_2)^+$ $(LiH)^+$ or $(BeH)^{++}$. Furthermore some molecules possess excited electronic terms in which their energy of dissociation is considerably increased as compared with that for the ground level, and it was found that this phenomenon occurs just with molecules possessing free valencies.[11] It was possible to give a simple explanation from the pair bond view, whereas the other viewpoint is at a loss to explain this phenomenon in a simple way. Similar results obtain with regard to the linkage of atoms, possessing a helium-like configuration of two *s*-electrons, like the atoms of the second group or C in $CO_2$.[12] The $s^2$ group acts repulsively according to spectroscopical evidence and wave-mechanical calculation and these bonds can be understood easily in a pair bond theory as arising from excited atoms, whereas the single electron bond interpretation of the theory should expect a different term as the ground level of these molecules. As regards the point of view of chemistry, it has been shown recently that there exists no experiment which proves the Octet Theory and that experimental evidence favours rather a uniform pair bond theory.[13]

The question as to whether non-localised wave-functions, *i.e.*, independent electrons, or localised functions, *i.e.*, electron pairs with strong mutual interaction, describe the molecule better, can be decided by the incapability of the non-localised functions, to describe the process of dissociation. The view of the single electron bond theory leads automatically to an incorrect statement as to the products of this process. If in $H_2$ the two electrons are treated as independent, the products of dissociation are 50% H+H and 50% $H^+ + H^-$, which of course is far from the truth. The same obtains in polyatomic molecules. This takes place, because the non-localised wave-function of the molecule contains also the ionic terms of $H^+$ and $H^-$ in too high a percentage, and this is a direct expression of the independence of the electrons. If the two electrons have no interaction other than a screening effect, then indeed the probability of either electron, to go with one or the other of the nuclei, is always 50% and it does not matter, if the other electron is already in the vicinity of this particular nucleus or not. If there exists, however, a strong mutual influence between the two electrons, the choice of the second electron, to go with a particular

[11] H. Lessheim and R. Samuel, *Zs. f. Phys.*, 1933, **84**, 637; **88**, 276.

[12] H. Lessheim and R. Samuel, *Proc. Phys. Soc.* (London), 1934, **46**, 523.

[13] R. F. Hunter and R. Samuel, *J. C. S.*, 1934, 1180; *Chem. and Ind.*, 1935, **54**, 31. *Rec. Trav. Chim.*, P. B, 1935, **54**, 114.

nucleus, will depend also on the choice of the first one and the probability of going to that particular nucleus, to which also the other electron belongs, will be much less than that of going to the nucleus which is still without an electron. The pair bond interpretation naturally pictures the molecule with a strong interaction inside the electron pairs and a weak interaction from pair to pair. Therefore neither strictly localised wave-functions, in which the interaction from pair to pair is missing and not containing the ionic terms at all, nor strictly non-localised functions without any interaction but with the full weight of the ionic terms are a correct description. Slater therefore could show that in the first wave mechanical method about which we spoke above, a certain percentage of the ionic terms has to be introduced, or in the molecular orbital method, the excessive influence of the ionic terms has to be cancelled to come to satisfactory results with regard to dissociation. Thus the two views approach each other.[14] Sometimes it was believed that in polyatomic molecules the localised wave functions of the pair bond interpretation represent a poorer mathematical approximation. If it would be true that the approximation by non-localised functions is mathematically the better one, this would be indeed a serious argument against the pair bond view. The discussion concerned particularly the linkage between two atoms with one *s* electron each and a central atom with two *p* electrons, the linkage s – p² – s, as in $H_2O$ or $CH_2$. It could, however, be shown that those functions which form the somewhat poorer approximation have still the disadvantage that they yield wrong percentages of dissociation products. If a different procedure, which gives the correct products of dissociation, is followed, wave-functions are obtained which yield not only almost localised bonds but also an improvement of the approximation.[15]

Thus we see that in the method of molecular orbitals two interpretations are possible and these represent just those two schools of thought, which existed already in pre-wave-mechanical theories of linkage. The interpretation by independent electrons is certainly sufficient for the description of the completed molecule, but as soon as any question connected with the transition to greater internuclear distances, *i.e.*, with the dissociation of the molecule arises, the interpretation by the electron pairs is superior both from the viewpoint of mathematics and experimental physics. The theory of valency is certainly concerned more with the process of dissociation or formation than with the description of the completed molecule. Combining all the different points of view, chemical evidence, band spectra, and the analytical representation of the molecule, it can be shown that the pair bond interpretation results in a self-contained theory in which all the difficulties of the other view disappear.[15] To our mind, therefore, the balance of probability rests with the pair bond theory and we have to picture the linkage in a normal molecule like $SF_6$ as produced by six bonds each of them almost completely localised between the S and one of the F nuclei. There is no difference at all between these six linkages. The real field of application of the non-localized wave-functions and many a beautiful explanation of complicated chemical questions by them is given in the aromatic substances, where indeed the electrons of the benzene ring have to be considered as non-localised, *i.e.*, as belonging equally to all the carbon atoms. The degeneracy of the nuclear fields on the other hand answers mainly for those effects, which are connected with the polarity of the molecule, as the transition from covalent to electrovalent linkage or the inductive effect, used in modern organic chemistry. With these questions we cannot deal here. If, however, we confine ourselves to normal molecules, it appears as if a uniform pair bond theory will answer best the requirements of chemistry and physics.

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[14] J. H. Van Vleck, *J. Chem. Phys.*, 1933, **1**, 177, 219; 1934, **2**, 20.

[15] H. Lessheim and R. Samuel, *Proc. Ind. Acad. Sci.*, 1935, **1**, 623. *Nature*, 1935, (Febr. 9th), p. 230.

## Major-General Sir Robert McCarrison, Kt., C.I.E., M.D., D.Sc., F.R.C.P.

BY the retirement of Sir Robert McCarrison the Indian Medical Service has lost one of its ablest officers, and this journal a valued contributor and well-wisher. I have endeavoured in this article to give a brief outline of Sir Robert's work in India, with special emphasis on the more important and striking contributions that he has given to medical science.

Sir Robert McCarrison entered the Indian Medical Service in 1901. His first [illegible] years of service (1902–1904) he spent in Chitral. It was fortunate that at the out[illegible] [illegible] met with a problem (Chitral Fever) which stimulated him to observe closely an[illegible] deduce. Prior to this, Chitral Fever [illegible] been regarded as malaria and treat[illegible] such. McCarrison studied it closely

Major-General Sir Robert McCarrison, Kt., C.I.E., M.D., D.Sc., F.R.C.P.

from its clinical and epidemiological features showed it was not malaria but a hitherto undescribed disease, and he suggested the sandfly as the most likely vector. He showed his Report in 1905 to Sir Patrick Manson who suggested the name "Three-day Fever of Chitral". McCarrison's descriptions of the fever appeared in the *Indian Medical Gazette* of January 1905. His suggestions were later confirmed by various observers, but to McCarrison would appear to belong the credit of first describing Chitral Fever as a definite entity and suggesting its vector.

On leaving Chitral, McCarrison entered the Foreign and Political Department and was posted to Gilgit. Here he commenced the series of observations and experiments which attracted immediate attention and placed him at once as a research worker and an observer and experimentalist of the first order. In Gilgit he made an epidemiological, clinical, therapeutic and experimental study of goitre, cretinism, deaf-mutism and endemic tetany. Goitre was here endemic in certain villages and McCarrison set himself to study the causes of this endemicity. He observed that the water drunk in such villages was highly polluted, and he produced goitre in himself and on some other human volunteers by drinking night and morning the residue left on the candle of a Berkfeld filter, after filtration, of grossly polluted drinking water, which had passed through a village where goitre was highly endemic. He further showed that goitre thus produced was in its early stages curable by intestinal antiseptics (thymol, etc.) and by shock doses of vaccines (coli, staphylococcus, etc.). In Gilgit also he described a new type of cretinism which was due to involvement of both the thyroid and parathyroid glands. His work here attracted great attention and raised hopes that we had here a worker of first rate capabilities with imagination, insight and originality who would attack problems from an independent view-point; and further work on goitre was confidently awaited. In 1911 he left Gilgit on furlough to England where he was invited to deliver the Milroy Lectures at the Royal College of Physicians in London (January 1913). These lectures were published in book form with the title "*The Aetiology of Goitre*" which is still an excellent resumé of the knowledge up to that time. During this period he studied goitre in the Alps and Switzerland.

He returned to India in 1913 and commenced work with the Indian Research Fund Association, a connection which was maintained uninterruptedly until the present year on his retirement. He first worked at Kasauli on an *Enquiry on Goitre and Cretinism* under the Indian Research Fund Association. This work was largely experimental and he was able to produce goitre in animals under experimental conditions, and what was more important, congenital goitre and congenital parathyroid disease and cretinism in their offspring, the former by feeding the animals either on cultures of faecal bacteria or a faecal bacteria from goitrous persons. The congenital manifestations were obtained by feeding the mothers throughout pregnancy on anaerobic cultures of faecal bacteria from goitrous persons. This was the first occasion in which congenital goitre and cretinism had been produced by natural means, as opposed to operative means on the thyroid gland of the mother. During this time also his important study of an epidemic outbreak of goitre in the pupils of the Lawrence Military School at Sanawar was undertaken and the substitution of a pure for a polluted water supply caused the disappearance of the goitre. It will be remembered that later with the co-operation of Newcomb, Norris and Nath, he re-investigated this outbreak from the point of view of iodine content of the local water supplies and found that the old polluted water supply actually contained more iodine than the new one.

It was during this period at Kasauli that McCarrison commenced the study of dietary with which his name has become so widely associated. He began work on the effects of vitamin deficiency in the animal organism, his first observation of importance being the marked lowering of resistance to infection brought about by vitamin deficient diets.

Then came the war in 1914. McCarrison went to Egypt and was employed as Registrar in a large Indian General Hospital. His experience here was later taken advantage of by the Government of India when he served on a Committee appointed to re-organize Military Hospitals. While in Egypt his health broke down and he was sent to England where he was placed in charge of the Malaria Investigation Hospital. While here he wrote his book *The Thyroid Gland in Health and Disease* (1917). In 1918 he returned to India and was posted to Coonoor where he again began his work

on nutrition which has continued uninterruptedly for the last 17 years. This period of work has been conducted under the auspices of the Indian Research Fund Association which has been quick to recognise opportunities for research in nutrition, generously providing funds year by year for his investigations. To review adequately the whole of the work turned out by McCarrison and his colleagues during these 17 years would take too much space, and I confine myself to indicating what have been in my opinion the main and outstanding features of this work. From 1918 to 1922 there appeared in the *Journal of Medical Research* a series of papers on the Pathogenesis of Deficiency Diseases, which threw a flood of new light on the subject of deficiency diseases. Hitherto the study of these diseases had been mainly clinical. McCarrison instituted a new principle by undertaking complete post-mortem examinations of deficiently fed animals, examinations that included the histopathological study of all organs and tissues of the body. He definitely established the important facts that faulty and ill-balanced dietaries deficient in vitamins lower the resistance of the animal organism to attacks by microbic agents of disease and such faulty food leads to depreciation of cellular function generally throughout the body, specific deficiencies of course causing specific effects.

These two fundamental generalisations have formed the basis of most of the later work in various countries on the pathogenesis of deficiency disease. McCarrison's description of the effect of faulty food deficient in vitamins on the gastro-intestinal tract was an observation of first rate importance, and has been described by Garrison in his *History of Medicine* as "one of the most significant contributions to the rôle of nutrition in preventive medicine". Of high importance too was the demonstrations of the remarkable effects of food deficient in vitamin A and C on the adrenal glands. This work on the depreciation of cellular functions and its results in manifest disease is probably McCarrison's main gift to nutritional science.

His book "Studies in Deficiency Disease" collected his work and his ideas in concrete form. In this he showed that the "deficiency diseases" so called such as scurvy, xerophthalmia, beri beri and the like are but particular manifestations of diet deficiency, but that faulty foods and faulty nutrition resulting therefrom, had a much wider application. The long continued use of diets containing too little of the vitamin factors necessary for optimum health is far more important than a complete deficiency, and is much more widely prevalent in human dietaries. The implications of this truth are becoming more and more apparent, and correction of faulty dietaries would result in the reduction and disappearance of many ordinary diseases, gastro-intestinal, urinary, pulmonary, and others, and especially in many widespread symptoms of disease, which ordinarily are not associated in the mind of the profession or the public with diet and nutrition. McCarrison's experimental work on the dietaries of India is well known, and though appreciated, is not acted on sufficiently.

His healthy rat colony in Coonoor which he has maintained during the last 5 years in perfect health, with no disease except old age and no infantile mortality, has been very impressive, and has been obtained by minute attention to diet, cleanliness and comfort. As he says himself "diet and dirt, including insect vectors of disease, are the two great causes of illness, and they are partners in crime". But in these later years his first love study, goitre, has not been forgotten. On the experimental side he produced (and he was the first to do so) the "lymph-adenoid" type of goitre experimentally, which had been demonstrated by Williamson and Pearse in man. The Memoir of the *Indian Journal of Medical Research* "The Life Line of the Thyroid Gland" in collaboration with Professor Madhava is a masterly piece of work, and will be constantly referred to not only for its informative matter, but as a model of presentation and analyses of experiment, observation, and comment. His crowning work on goitre was the presentation at the request of the Swiss Goitre Commission of the Principal Report on the Aetiology of Goitre at the Second International Congress held at Berne in 1933.* His little book on "Food" was a gift to the children of India and it has now been translated into Urdu, Punjabi, Hindi, Kanarese, Tamil and Malayalam.

It is pleasant to record that Sir Robert has not been without honour, both in his own country, by which I mean here

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* For a summary of this Report, see *Curr. Sci.*, 1933, **2**, 133.

India, and outside. In 1911 he was awarded the Kaiser-i-Hind 1st class "for public services in India". In 1916 he was awarded the Prix Amussat by the Academy of Medicine, Paris, with the title of Laureate of the Academy. In 1914 he was appointed a Fellow of the Royal College of Physicians of London. In 1918 he was awarded the B. M. A. Prize for Research, and made an Honorary LL.D. of the Queen's University, Belfast. In 1918 also he was gazetted Brevet Lieutenant-Colonel for distinguished service in the field. In 1927 he was made the Honorary Physician to the King and Brevet Colonel. These last were made in recognition of the work he was then doing, following the publications of the Report of the Royal Commission on Agriculture. These honours were fittingly rounded off by the honour of Knighthood conferred on him by His Majesty the King in 1933. Many other academic distinctions and compliments have been paid to him. He was invited to give the de Lamar (Baltimore), the Mellon (Pittsburg), the Mary-Scott Newbold (Philadelphia), the Mayo-Foundation (Rochester), and other lectures in the U. S. A. of 1921. He was appointed in 1922 one of the 20 Honorary Fellows of the College of Physicians of Philadelphia. In 1931 he delivered by invitation special lectures at the Royal College of Surgeons of London on "The Causation of Stone in India" and "Some Surgical Aspects of Faulty Nutrition."

Sir Robert McCarrison's work in India has been brilliant, inspiring and abiding. His main ambition to establish an Institute of Nutrition in India worthy of the country and of the subject has unfortunately not been fulfilled, but his Unit of Research on Nutrition established at Coonoor, which is one of the oldest in the world, will remain and, we hope, prosper. Those who have heard Sir Robert speak either formally or informally will not forget his distinguished presence, his fine voice, and his polished diction. He is a born and natural orator. His exposition of his subject is ideally clear and interesting and he can use his gifts of speech in persuasion of what he thinks is right and in fearless denunciation of what he thinks is wrong. He was a gifted enthusiast throughout his service and used his talents and energy unceasingly and ungrudgingly in the cause of science and in the cause of India. He loved and loves India and its peoples, and his aim was and is that younger generation of Indian scientists should be given ample opportunities for training and service for the advancement of science in India. His style in writing is lucid, simple, forcible, and telling, and is based to some extent at any rate on an intimate perusal and acquaintance with the Old and New Testaments which he thought models for everyone who wished to improve their speaking and writing in English. As a friend, he combines charm and sincerity and many of us have benefitted by his experience and advice.

Sir Robert McCarrison leaves India with the regret and the best wishes of all his colleagues and thousands of others. We wish him joy in his retirement, but we know he will not be idle. He proposes to settle in Oxford where he will have, we hope, opportunities of passing on to the younger members of our profession what he himself learned and of showing them the paths along which there is still so much to be discovered.

A. D. STEWART.

## Director of Nutrition Research in India.

DR. W. R. AYKROYD has been offered the appointment of Director of Nutrition Research in India.

Dr. Aykroyd has held the appointments of House Surgeon and Physician, Adelaide Hospital, Dublin, 1925, and Resident Medical Officer, Government General Hospital, St. Johns, Newfoundland, 1926–1927. While in the latter appointment he undertook an investigation of beri beri and other food deficiency diseases. He was granted a Beit Memorial Research Fellowship 1928–1931, the Fellowship being given for combined field and laboratory work on nutrition. In 1931 he secured appointment as member of the Health Section, League of Nations, Geneva, which he still holds. In connection with a report he prepared in 1933 on 'Nutrition in Relation to Public Health' he visited a number of European countries, the U.S.A. and Canada making personal contact with public health workers interested in the problems of nutrition, and studying methods employed in each country.

# Letters to the Editor.

## CONTENTS.



## Influence of "Swelling" on the Abnormal Unidirectional Diamagnetism of Graphite Crystals.

GRAPHITE crystal (which is hexagonal and has a perfect basal cleavage) exhibits remarkable magnetic and electrical properties. Its diamagnetic susceptibility[1] along the vertical axis is abnormally large, about $-22\times10^{-6}$ pergm., while for directions in the basal plane it is practically the same as that of diamond, *viz.*, $-0\cdot5\times10^{-6}$. Electrically, the crystal is a good conductor for directions in the basal plane. These abnormal properties may be traced to the peculiar structure of the crystal. While the three equivalent linkages of the carbon atom in the basal plane of the crystal are homopolar, the fourth weak linkage, which binds the widely separated successive layers of carbon atoms, is generally regarded as "metallic". If the large displacements of these "metallic" electrons under the influence of electric and magnetic fields are confined predominantly to the basal plane, the electrical conductivity along the plane, and the abnormal susceptibility for magnetic fields incident along the normal to the plane, receive a natural explanation.

The "swelling" of graphite to "blue graphite" (as also its further oxidation to graphitic oxide) is generally regarded as corresponding to the adsorption of oxygen atoms between the carbon layers, the metallic linkages being broken thereby.[2] We should therefore expect both the conductivity and the abnormal diamagnetism to disappear on "swelling". It is known that the oxidation of graphite destroys its conductivity. Its effect on the abnormal diamagnetism does not seem to have been studied.

A small single crystal of graphite was treated with a mixture of concentrated nitric and sulphuric acids for about 12 hours. The resulting "blue graphite" was washed in running water for over 12 hours and dried in a desiccator. The specimen had the same hexagonal shape as the original graphite piece, and was also found to be roughly a single crystal, as tested by its X-ray diffraction. On measuring its principal diamagnetic susceptibilities it was found that

(1) for directions in the basal plane, its specific susceptibility is practically the same as that of untreated graphite;

(2) on the other hand the magnetic anisotropy, *i.e.*, the difference $\Delta\chi$ between the two principal susceptibilities, which is as high as $22\times10^{-6}$ per gm. in untreated graphite, is now diminished to about $1{\cdot}3\times10^{-6}$ per gm. of carbon; *i.e.*, the abnormal diamagnetism of graphite along its '*c*' axis is almost completely destroyed by the "swelling".

It is significant that the above value for the magnetic anisotropy of oxidised graphite is of the same magnitude as in compounds containing condensed benzene nuclei, *e.g.*, pyrene, for which $\Delta\chi=1{\cdot}2\times10^{-6}$ per gm. content of carbon.

Further it is known that as the size of the graphite particle is continually diminished (to that corresponding to "amorphous" carbon), the distance between the successive layers of carbon increases correspondingly. This has been taken by Randall and Rooksby[3] to indicate a weakening of the metallic valency bonds of the carbons. In that case the diminution in the diamagnetism of graphite powder with the particle size, observed by Honda, Paramasivan and others, would be a natural consequence. In this connection the following observation is of interest. Some preliminary measurements made by us on the principal susceptibilities of crystallites of graphite show that, while the susceptibility along directions in the basal plane is practically independent of particle size, and has a constant value near about $-0{\cdot}5\times10^{-6}$, it is the susceptibility along the '*c*' axis, which is abnormal in large crystals, which diminishes with decreasing particle size.

K. S. KRISHNAN.
N. GANGULI.

210, Bowbazar Street,
Calcutta,
*March* 27, 1935.

[1] Guha and Roy, *Ind. Jour. Phys.*, 1934, **8**, 349.
[2] Hoffmann, *Koll. Zeits.*, 1932, **61**, 297. See also Desch, *Chemistry of Solids*, 1934, p. 180.
[3] See Randall, *Diffraction of X-rays*, London, 1934, p. 192.

## Convection Currents in an Unstable Layer of Fluid studied by Optical Methods.

THE convection currents set up in a thin horizontal layer of a liquid by an unstable distribution of density have been studied experimentally by many investigators. Following Bénard, the usual method of making the movements visible is to mix with the liquid fine particles of some shining substances such as aluminium or "gold" paint. Simple optical methods enable the phenomena to be studied in much greater detail.

A horizontal layer of liquid is obtained by floating it on clean mercury. The surface of a volatile liquid like ether or alcohol cools rapidly by evaporation resulting in an unstable distribution of density. With less volatile liquids, instability can be produced by placing the tray of mercury on a flat heater. If we reflect the divergent beam of light coming from a point source of light at the mercury surface at nearly normal incidence and receive the reflected beam on a screen, a pattern is formed on the screen showing the local deviations of optical thickness of the evaporating layer. Bright points and lines correspond to convergence of beam (cooler liquid or increased thickness) and dark points and lines to divergence. The liquid behaves as a composite lens backed by a plane reflector.

Figs. 1 to 5 show the successive stages of the appearance of the pattern on the screen as a layer of ether floating on mercury gradually gets thinner. When the layer is more than 4 mm. thick, prominent dark canals and rapidly moving thin bright filaments make their appearance. The former are regions at which the liquid ascends. When the thickness is 2–3 mm., the bright filaments converge to a series of lines or points surrounded by the dark canals. As the film gets thinner, the movement becomes less brisk, the dark canals get narrower and the bright spots in the middle of the cells get more concentrated and become connected together by bright lines. After a certain stage, the dark lines become invisible, but

**Fig. 1.**
Ether; thickness c. 7 mm.

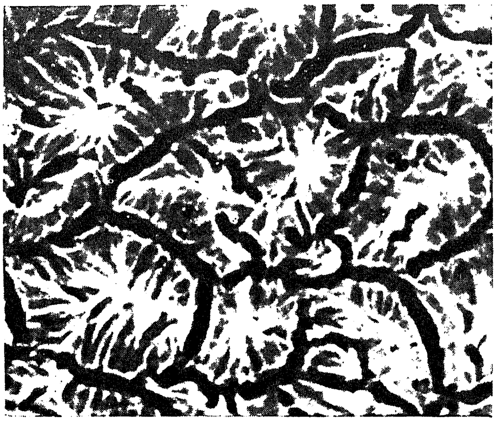

**Fig. 2.**
Ether; thickness c. 3 mm.

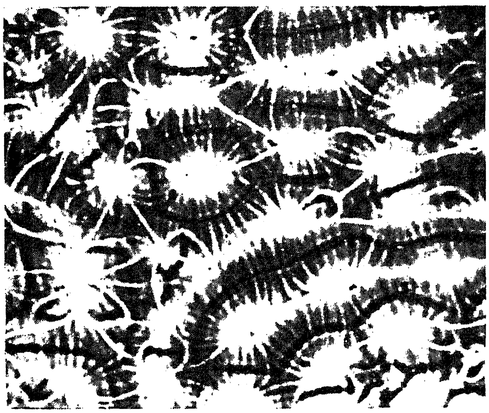

**Fig. 3.**
Ether; thickness c. 2 mm.

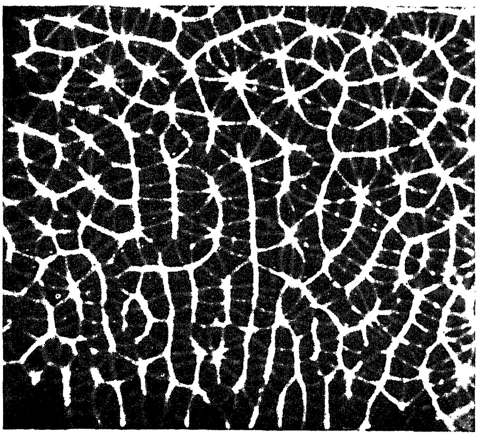

**Fig. 4.**
Ether; thickness c. 1 mm.

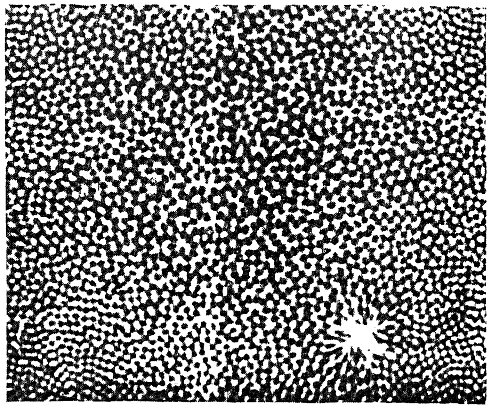

**Fig. 5.**
Ether; thickness c. 0·2 mm.

in this condition also, we have ascending movement in the middle of each bright-bordered cell and convergence and descending movement at the boundaries. A noteworthy feature of the vertical circulation in each individual cell is that the movement in the upper level is much more rapid than in the lower. This is easily verified by observation of floating specks of dust. As the film approaches the vanishing stage, the field is covered by a net-work of alternately bright and dark cells and just before vanishing, the film becomes continuous.

If instead of ether, we use a less volatile (and also more viscous) liquid like carbon tetrachloride, the movements are generally more sluggish but the sequence of changes is essentially the same; when the liquid layer is very thin, it divides itself into remarkably regular hexagons (Fig. 6). The regularity is

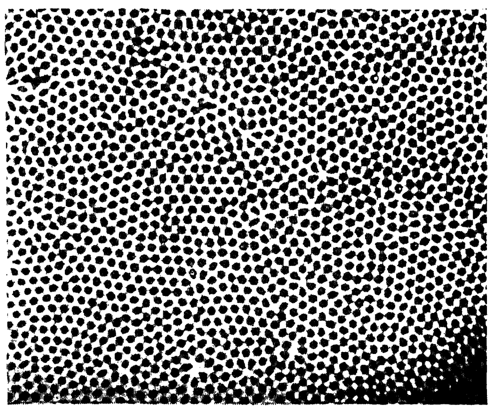

**Fig. 6.**
Carbon tetrachloride; thickness c. 0·2 mm.

dependent on a proper balance between density-gradient and viscosity.

If the unstable liquid has a translatory movement, the cells arrange themselves along the line of movement accompanied by characteristic changes of shape. Figs. 7 and 8 obtained with carbon tetrachloride

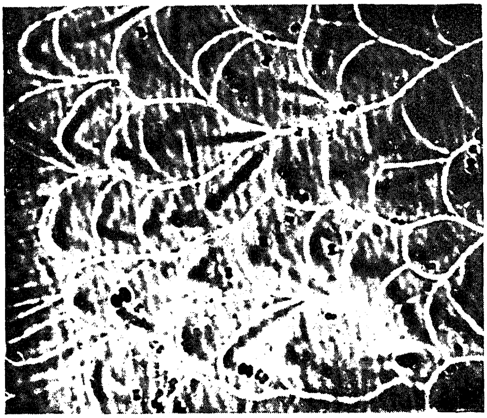

**Fig. 7.**
$CCl_4$ moving towards the right.

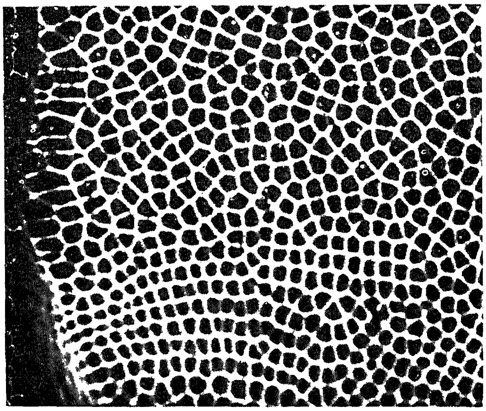

**Fig. 8.**
$CCl_4$ moving towards the right.

illustrate this. Their similarity to cloud forms has been studied by Mal, Walker, Phillips and others.

The influence of temperature-gradient, viscosity and heat-conditions of the liquid in determining the instability and the patterns of cell-structure is being investigated in the light of theories developed by Lord Rayleigh and H. Jeffreys. The Schlieren method can also be used to show up the cells, but the shadow method is simpler. Attempts are being made to apply these methods to study the vortices in gases.

K. R. RAMANATHAN.
V. N. KELKAR.

Poona,
*April* 4, 1935.

### Induced Radio-Activity.

As a result of the neutron bombardment induced radio-activity by the liberation of $\beta$-particles has been examined in a large number of cases by Fermi and his collaborators.[1] These results are interesting as in almost all cases the active products were ascertained by chemical methods of separation and examination. According to Fermi's reactions elements of odd atomic and mass numbers are, in general, transmuted to radioactive elements with expulsion of $\alpha$-particles and those of even atomic and mass numbers transmuted to similar active elements with expulsion of protons. The reactions can be represented by the following typical examples.

$$Al^{27}_{13} + n^1_0 = Na^{24}_{11} + \alpha \quad .. \quad (1)$$

$$Mg^{24}_{12} + n^1_0 = Na^{24}_{11} + p \quad .. \quad (2)$$

$$Na^{24}_{11}(\text{active}) \rightarrow Mg^{24}_{12} + \beta.$$

A second type of reactions by expulsion of protons in the cases of some of the elements of odd atomic and mass numbers is also given by Fermi thus:—

$$P^{31}_{15} + n^1_0 = Si^{31}_{14}(\text{active}) + p$$

$$Si^{31}_{14} \rightarrow P^{31}_{15} + \beta \quad .. \quad (3)$$

It may be interesting to point out here that this second type of reaction with liberation of protons is rather uncommon at least in the case of heavier odd numbered elements. Expulsion of protons from elements of light nuclei will also be shown to take place very seldom.

A third type of reaction in which neutrons are simply or directly captured within the nucleus of the bombarded atoms (without the expulsion of a proton or an $\alpha$-particle) and thus forming a heavier and active isotope of the parent atom may also be possible. If the reaction of the third type be postulated for Na, it should be represented thus—

$$Na^{23}_{11} + n^1_0 = Na^{24}_{11}(\text{active}) \rightarrow Mg^{24}_{12} + \beta \quad .. \quad (4)$$

The active product $Na^{24}_{11}$ having a decay period of about 15 hrs. has however been obtained only as a secondary product due

to the expulsion of a proton from Mg or by the expulsion of an $\alpha$-particle from Al. Fermi has found that the activity in association with Na bombarded with neutron has only a period of 40 secs.—which is certainly in disagreement with the formation of $Na^{24}_{11}$ from Na as postulated in (4). Bjerge and West-cott[2] have reported a very weak activity from Na, the period of which is about 10 hrs. This they attribute to the direct formation of $Na^{24}_{11}$ in accordance with the above reaction (4)—which may not be true in view of the discrepancy of the observed period of decay. To supplement the above contention, it may be cited that the direct transformation of $Al^{28}_{13}$ into $Al^{27}_{13}$ (decay period 3 mins.) by simple neutron attachment is not observed, as none of the two radiations given out by bombarded Al corresponds to this period. Similarly $P^{32}_{15}$ (decay period roughly 13 days) does not correspond to any of the radiations given out by P and thus the view that at least in the cases of Na, Al and P[3] bombarding neutrons may be simply embedded into the nucleus of their parent atoms seems untenable. The activity of Na observed by Bjerge and West-cott might possibly be due to a reaction product obtained by expulsion of a proton according to the second mode of reaction

$$Na^{23}_{11}+n^1_0=Na^{23}_{10}+p$$

In the case of F, Bjerge and West-cott (*loc. cit.*) have observed a decay period of about 40 secs. This agrees with the decay period of Na as noticed by Fermi. The reaction product in this case appears to be certainly due to the direct attachment of the neutron to F-nucleus as represented in $F^{20}_9$. Na and F thus probably give rise to the same radio-active element according to the following reactions:—

$$Na^{23}_{11}+n^1_0=F^{20}_9+\alpha \qquad .. \qquad .. \quad (1)$$

$$F^{20}_9+n^1_0=F^{20}_9 \qquad .. \qquad .. \quad (4)$$

According to Fermi, Mg also gives a decay period of 40 secs. which if it exists is very likely also due to $F^{20}_9$. This leads one to think that under neutron bombardment Mg may also decompose successively by emitting a diplon and then an $\alpha$-particle thus—

$$Mg^{24}_{12}+n^1_0=Na^{23}_{11}+D^1_2$$

$$Na^{23}_{11}+n^1_0=F^{20}_9+\alpha$$

Direct attachment of neutrons to the nucleus of the bombarded atom as a primary process seems however more frequent in the case of heavy elements

$$K^{39}_{19}+n^1_0=K^{40}_{19}\text{ (unstable)}\rightarrow Ca^{40}_{20}+\beta.$$

Hevesy, Pohl and Hosemann[4] by a partial separation of the K-isotopes observed that the natural radio-active product was associated with a heavier isotope of K whose mass according to the determination of Baxter was equal to 40. Fermi and others[5] observe that by bombarding K with neutrons a heavier active isotope of K having a decay period of 16 hrs. has only recently been obtained. Unstable isotopes of V(52), Mn(56), Cu(64), As(76), Br(80, 82), and Rb(86) are found to originate from their parent substances by such simple neutron captures. Probably such simple attachments of neutrons to the nuclei of the bombarded atoms in the cases of heavy elements is rather more common and on many occasions the only form of reaction possible.

Regarding the inactivity of N under neutron bombardment as observed by Fermi, it may be remarked that the simple or direct neutron capture to the nucleus of N(14) without the following expulsion of protons or $\alpha$-particles is rather improbable though N(15) might be transformed into N(16)—this, however, certainly does not form a stable group even for the least appreciable time. N(16) has however been obtained from F as a secondary product having a period of about 9 secs. (compare the cases of Na, Al and P). A form of direct neutron capture to the nucleus of N(14) or of O(16) giving an intermediate and very transient product forming N(15) or O(17) which is then immediately disrupted with emission of $\alpha$-rays has been postulated by Feather[6] and Harkins, Gans and Newson[7]. N(14) of even mass number will not probably emit $\alpha$-rays according to Fermi; rather an expulsion of proton is to be expected. Kurie observed the photographic tracks in a Wilson's cloud chamber in a mixture of N and O which revealed expelled particles of smaller charge than that of an $\alpha$-particle —the expelled particles according to him might be a proton, a Diplon, or a $H^3_1$. Kurie suggests expulsion of protons as the most probable. The product of such a reaction should be radio-active liberating $\beta$-rays which is also negatived by Fermi's observation.

C and O are reported by Fermi to be non-active under neutron bombardment; probably therefore no protons are expelled

from them. Most likely then there is truth in the other suggestion of Kurie that Diplons $D^2_1$ (as has been supposed to be expelled from Mg) are also given out from the nuclei of these light elements (N and O)—the reaction products in all these cases will however be stable and therefore will not radiate. Feather[6] is of opinion that during disintegration of N with neutron capture a Diplon is in fact expelled according to the reaction $N^{14}_{7} + n^{1}_{0} \rightarrow C^{13}_{6} + D^{2}_{1}$.

S. C. BISWAS.

Physics Department,
Dacca University.
February 15, 1935.

1 Fermi, Amaldi, Agostino, Rasetti and Segre, *Proc. Roy. Soc.* (A), 1934, **146**, 483.

2 Bjerge and Westcott, *Nature*, Aug. 25, 1934, 286.

3 Newmann and Walke, *Ibid.*, Oct. 6, 1934, 531.

4 Hevesy, Pohl and Hosemann, *Ibid.*, Sept. 8, 1934, 377.

5 Fermi, Amaldi, Agostino, Rasetti and Segre, *Ricera Scientifica*, Dec. 2, 1934.

6 Feather, *Proc. Roy. Soc.* (A), 1932, **136**, 709; 1933, **142**, 689.

7 Harkins, Gans and Newson, *Phys. Rev.*, 1933, **44**, 915.

8 Kurie, *Phys. Rev.*, 1934, **45**, 901.

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## A note on the method of determining the heat of dissociation from a study of the long wavelength limit of the Continuous Absorption by gas molecules.

MY attention has been drawn to a letter by S. Datta and B. Chakrobarty in the *Current Science* of the February issue. Before dealing with their criticisms, I would like to point out that the potential energy curves drawn in Fig. 1 of their note are not correct for the ionic case. The potential energy curves for the normal and the first excited states of the ionic molecule should intersect and not join each other to make a common energy level of dissociation. This is apparent and has been stressed upon by Franck[1] himself on many occasions.

Datta and Chakrobarty have assumed that under the conditions of experiment at ordinary room temperature there would be an increase of the vibrational energy of the molecules with increase of pressure and as such the long wavelength limit would shift towards longer wavelength. They have obtained experimental results in accordance with this hypothesis. But this hypothesis, which is the mainstay of their note, falls to the ground for the following two reasons:—

(1) In the case of HCl as a particular example, this apparent shift of wavelength limit takes place as one goes on increasing the pressure of the gas upto 1 atmosphere, keeping the temperature and the length of the gas column constant. But the specific heat of HCl at constant volume is 5·00 at 20°C. and one atmospheric pressure.[2] This tells that under these conditions all the energy is due to translatory and rotatory degrees of freedom. A real shift of the long wavelength limit is not, therefore, expected when we increase the pressure from low values upto one atmospheric pressure.

(2) The increase of oscillation energy with increase of pressure is against the principles of thermodynamics, so long as the temperature remains constant. For, it can be easily shown that

$$\left(\frac{\partial v}{\partial p}\right)_\tau \quad \text{is } -\text{ve.}$$

in a gaseous system that obeys Van der Waal's law. The proof is as follows:—

$$\text{we have } \left(\frac{\partial v}{\partial p}\right)_\tau = -\tau\left(\frac{\partial v}{\partial \tau}\right)_p - p\left(\frac{\partial v}{\partial p}\right)_\tau$$

from the general principles of thermodynamics, but

$$\frac{\left(\frac{\partial v}{\partial \tau}\right)_p}{-\left(\frac{\partial v}{\partial p}\right)_\tau} = \left(\frac{\partial p}{\partial \tau}\right)_v, \text{ which is a positive}$$

quantity, say $\alpha$.

$$\text{Hence, } \left[\left(\frac{\partial v}{\partial p}\right)_\tau = \tau\alpha\left(\frac{\partial v}{\partial p}\right)_\tau - p\left(\frac{\partial v}{\partial p}\right)_\tau\right]$$

$$= \left[(\tau\alpha - p)\left(\frac{\partial v}{\partial p}\right)_\tau\right]$$

Now $\left(\frac{\partial v}{\partial p}\right)_\tau$ is a negative quantity, and $\tau\alpha - p$ is always positive for a system obeying Van der Waal's law. For,

$$\left[\tau\alpha - p = \tau\left(\frac{\partial p}{\partial \tau}\right)_v - p = \frac{\tau R}{v-b} - p\right]$$

which is a positive quantity. Hence $\left(\frac{\partial v}{\partial p}\right)_\tau$ is negative. This means that for gases obeying Van der Waal's law, the total internal energy would diminish with increase of pressure the temperature remaining constant. As the oscillation energy steps are of a much higher order than the rotational energy values or the intermolecular potential energies,

there can be no increase of the oscillation energy value due to the increase of pressure.

The shift of the long wavelength limit with increase of pressure is thus only apparent as I have pointed out in my papers,[3] and this follows from considerations of the transition probabilities at different points in the upper curve, as shown by Trivedi[4] from wavemechanical considerations.

Moreover, the semiempirical criteria to define atomic and ionic molecules have since been modified along different lines.[5]

A. K. DUTTA.

Bose Institute,
Calcutta,
*October* 3, 1935.

[1] Franck and Kuhn, *Bull. U. P. Acad.*, 1933, **2**, 223.

[2] Saha and Srivastava, *Text-book of Heat*, p. 88.

[3] Dutta, *P. R. S.*, 1932, **84**, 138; *Z. f. P.*, 1932, **77**, 405.

[4] Trivedi, *U.P. Acad. Sci.*, 1934, **4**, 59.

[5] Franck, *loc. cit.*; Dutta and Deb, *Z. f. P.*, 1934, **93**, 127.

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APPARENTLY there has been some misunderstanding. What we conceived was the possibility of an increase in the number of molecules in the higher levels due to an increase in the "population" of the molecules in the lower level with a rise in the pressure and not an increase in the number due to any change in the vibrational energy with pressure.

The specific heat data, *viz.*, $C_v = 5$ for HCl does not shut out the possibility of the existence of vibrating molecules. For, even if the rotational states are developed upto ten quantum numbers ($j = 10$)—as evinced from infra-red data—the contribution to specific heat data by the rotational motion would be 1·808. This contribution due to translational motion would come up to 4·786 and the figure never reaches the value 5 even if the rotational states are assumed to be developed in full *i.e.*, $j = \infty$. Thus there is some contribution due to oscillation and this is further confirmed by the fact that HCl gas at ordinary temperature shows vibration-rotation spectra in the near infra-red ($n = 0 \rightarrow 1$, $n = 0 \rightarrow 2$) and the zero state of vibration according to wavemechanics has an energy $= \frac{1}{2}h\nu$. Once admitting that there are vibrating molecules, their distribution to different states according to Boltzmann's law would follow automatically.

The trouble that has been taken to show that $\left(\frac{\partial v}{\partial p}\right)_T$ is negative—a result which is given in all Text-Books of Thermodynamics—is useless; for this merely tells of the diminution in the total internal energy of the molecules and is equal to $-\frac{a}{v^2}$, caused by the fact that the molecular attraction increases with an increase in pressure. From this nothing can be inferred definitely regarding the effect of pressure on the oscillation energy. Had this diminution in internal energy meant the diminution of oscillation energy, bands arising out of higher vibrational transitions would have been suppressed with an increase of pressure. As is well known to the Spectroscopists, this never happens; on the contrary, working at constant temperature higher pressure is necessary to get the bands corresponding to higher vibrational transitions, which again confirms the view we have expressed in our note, that with an increase in pressure higher vibrational states may be developed mainly due to an increase in the "population".

The main point in our note, however, was not this theoretical issue but the *experimental fact that the curves showing the relation between percentage of absorption and wavelength in the cases of HCl, HBr* and $N_2O$ *tend to zero values of the percentages of absorption at values of wavelengths which are different for different pressures and not for the same value of the wavelength as observed by Dr. Dutta.*

We agree with Dr. Dutta that these semi-empirical criteria to distinguish the Atomic from the Ionic molecules are not very satisfactory. With regard to the potential curves Dr. Dutta is right; it should be stretched slightly upward so as to intersect at least one of the upper curves.

P. DUTTA.

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Calcutta.

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## Note on the Statistical Theory of Regular Solutions.

IN a recent note[1] a statistical theory of solutions was proposed, but in a subsequent paper[2] it was observed that this theory as well as that due to Guggenheim[3] suffers from the defect that gas laws have been tacitly assumed. Recently Guggenheim[4] has extended his theory to the case of regular solutions as defined by Hildebrand[5] and others. We propose to develop the theory in a straightforward and simple manner.

As suggested before[6] we assume the following relation

$$dn = e^{\frac{\psi}{kT}} F \triangle \tau$$

where $\psi$ is the free energy, F the partition function, the form of which is not known, $\triangle \tau$ the elementary phase volume. Consider a mixture of $n_A$ and $n_B$ molecules of substances A and B forming a regular solution in which $x$ molecules of each are present as A-B pairs. We then have

$$\psi_A = kT\, ln\, (n_A - x) - ln \int F \triangle \tau$$
$$\psi_A' = kT\, ln\, x - ln \int F \triangle \tau$$

where $\psi_A$ and $\psi_A'$ are the free energies of A molecule present as A-A pair and as a component of A-B pair respectively. Hence the change of free energy

$$\triangle \psi_A = \psi_A - \psi_A' = kT\ ln\ \frac{n_A - x}{x}.$$

Similarly we have

$$\triangle\ \psi_B = kT\ ln\ \frac{n_B - x}{x}.$$

Now the total change of free energy is equal to the increase of potential energy of the system

$$2\ (2\ w_{AB} - w_A - w_B)_r = 2\lambda/r$$

as defined by Guggenheim. $r$ is the number of molecules surrounding each pair. Hence

$$\triangle\ \psi = kT \left( ln\ \frac{(n_A - x)}{x} + ln\ \frac{(n_B - x)}{x} \right) = 2\lambda/r$$

from which we have $\frac{(n_A - x)\ (n_B - x)}{x^2} = e^{2\lambda/rkT}$

which on transformation reduces to Guggenheim's relation. Hildebrand's relation follows as a special case for $\lambda = 0$, *i.e.*, when the total change of free energy is zero.

A. GANGULI.

Chemical Laboratory,
College Dupleix,
Chandernagore,
*March* 25, 1935.

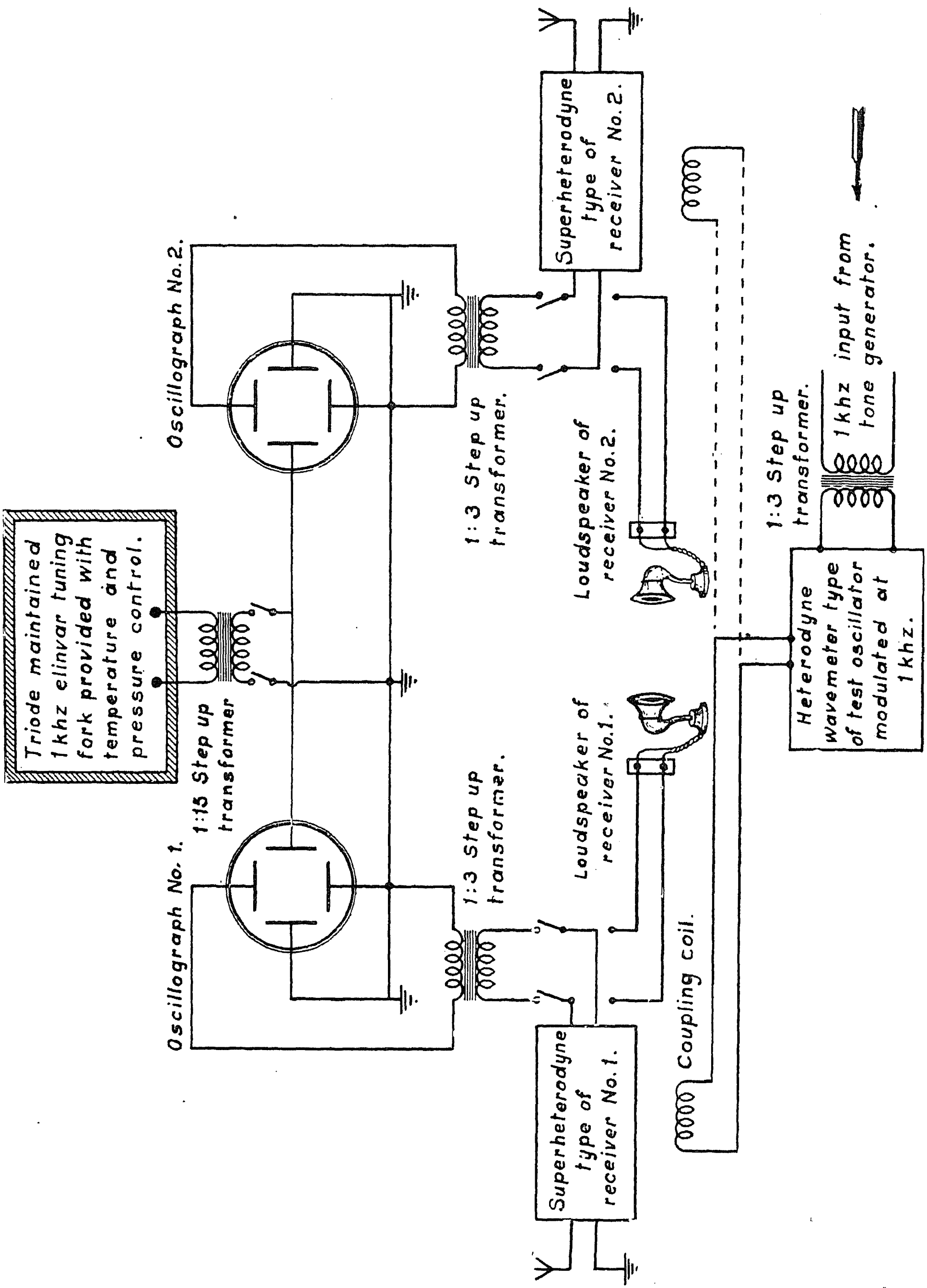
[1] Ganguli, *Curr. Sci.*, 1933, **2**, 212.
[2] Ganguli, *Koll. Z.*, 1934, **67**, 304.
[3] Guggenheim, *Proc. Roy. Soc.*, 1932, **A135**, 181.
[4] Guggenheim, *Ibid.*, 1935, **148**, 304.
[5] Hildebrand and Wood, *J. Chem. Phys.*, 1933, **1**, 818.
[6] Ganguli, *loc. cit.*, ref. 2.

## Special Radio Test Transmissions on 12th and 13th March 1935.

UNDER the auspices of the Union Radio Scientifique Internationale (URSI) and in continuation of the practice of the last two years, a frequency of 1 khz of high precision and stability obtained from the 1 khz standard tuning fork at the National Physical Laboratory in England was radiated in accordance with a previously notified schedule, as a modulation of the carrier frequencies of the broadcast transmitters, Droitwich (200 khz, 150 kw), Scottish Regional (801 khz, 50 kw) and Scottish National (1050 khz, 50 kw) of the British Broadcasting Corporation, England. These emissions took the form of a preliminary emission programme for adjustment purposes on 12th March between 0545 and 0615 IST; the main schedule of emissions of 13th March lasted from 0600 to 0845 IST. These emissions have the two-fold object (*a*) of intercomparison of national standards of frequencies or of calibration of local apparatus where primary standards do not exist; and (*b*) of making observations of a physical nature such as fading, etc., characteristic of the transmission path.

Recently, a multivibrator type of wavemeter equipment of up-to-date design and driven by a 1 khz elinvar tuning fork, maintained at a temperature varying little from 50°C and at a pressure of 75 mm. has been installed in the laboratories of the Department of Electrical Technology of the Indian Institute of Science, Bangalore, to serve as the reference standard for India. The frequency of this fork had been accurately measured at the National Physical Laboratory prior to shipment of the apparatus to India. But the measurement on 13th March of the frequency difference between the two 1 khz signals—either by the phonic wheel or by the beat note method—was found to be out of question on account of (*a*) the rapidly diminishing signal intensities at Bangalore of the incoming 801 and 1050 khz signals from early morning hours onwards, (*b*) fading and (*c*) atmospheric disturbances in relation to the signal strength. Comparatively speaking, the disturbances were far more severe on 200 khz, the frequency of Droitwich, and it was not without difficulty that the 1 khz modulating note could be heard. This station could not therefore be used.

For visual observations (Fig. 1), the output from each receiver was impressed across



Superheterodyne type of receiver No. 2.
Oscillograph No. 2.
1 : 3 Step up transformer.
Loudspeaker of receiver No. 2.
1 : 3 Step up transformer.
1 khz input from tone generator.
Triode maintained 1 khz elinvar tuning fork provided with temperature and pressure control.
1:15 Step up transformer
Heterodyne wavemeter type of test oscillator modulated at 1 khz.
Loudspeaker of receiver No. 1.
Oscillograph No. 1.
1 : 3 Step up transformer.
Coupling coil.
Superheterodyne type of receiver No. 1.


Fig. 1.

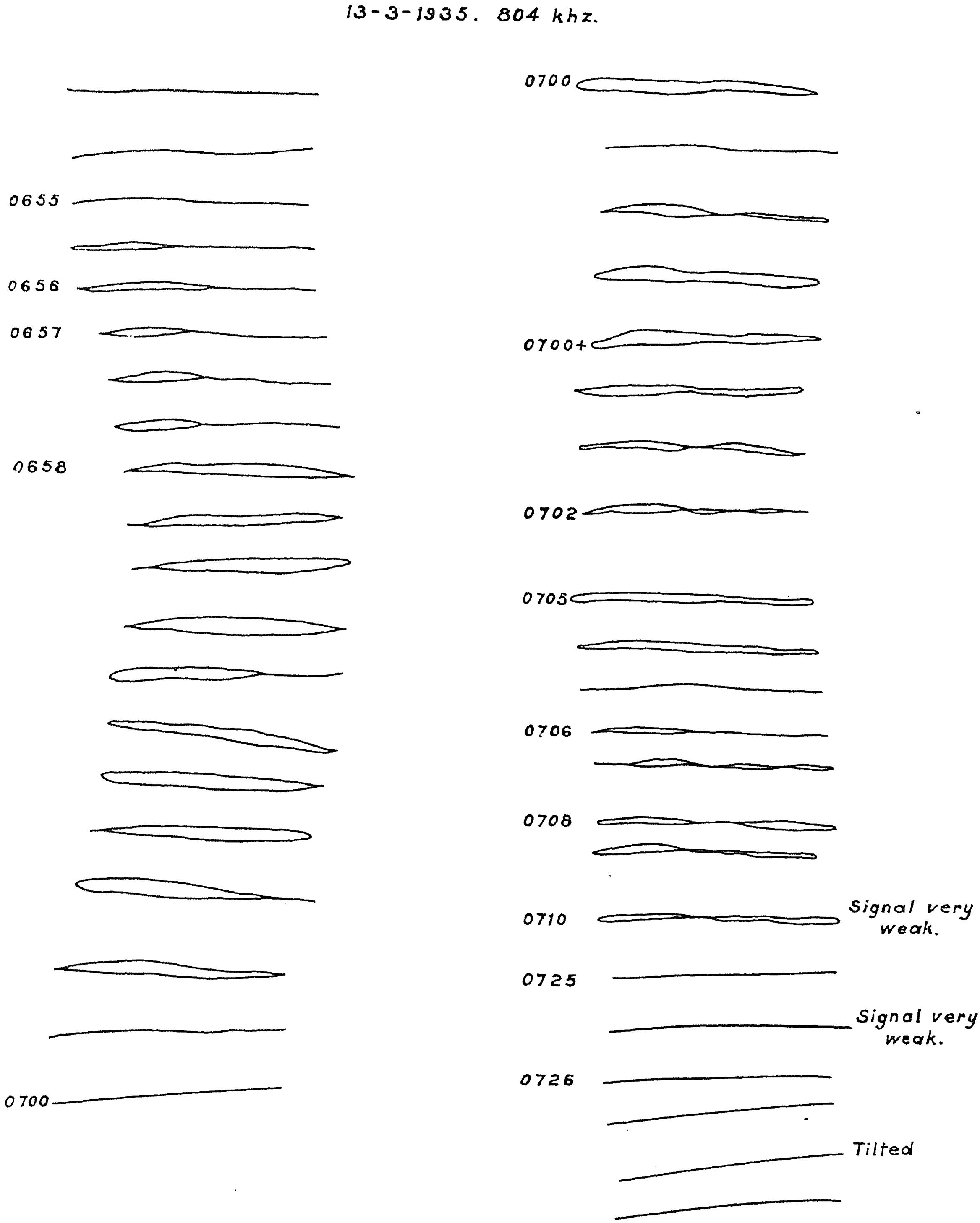
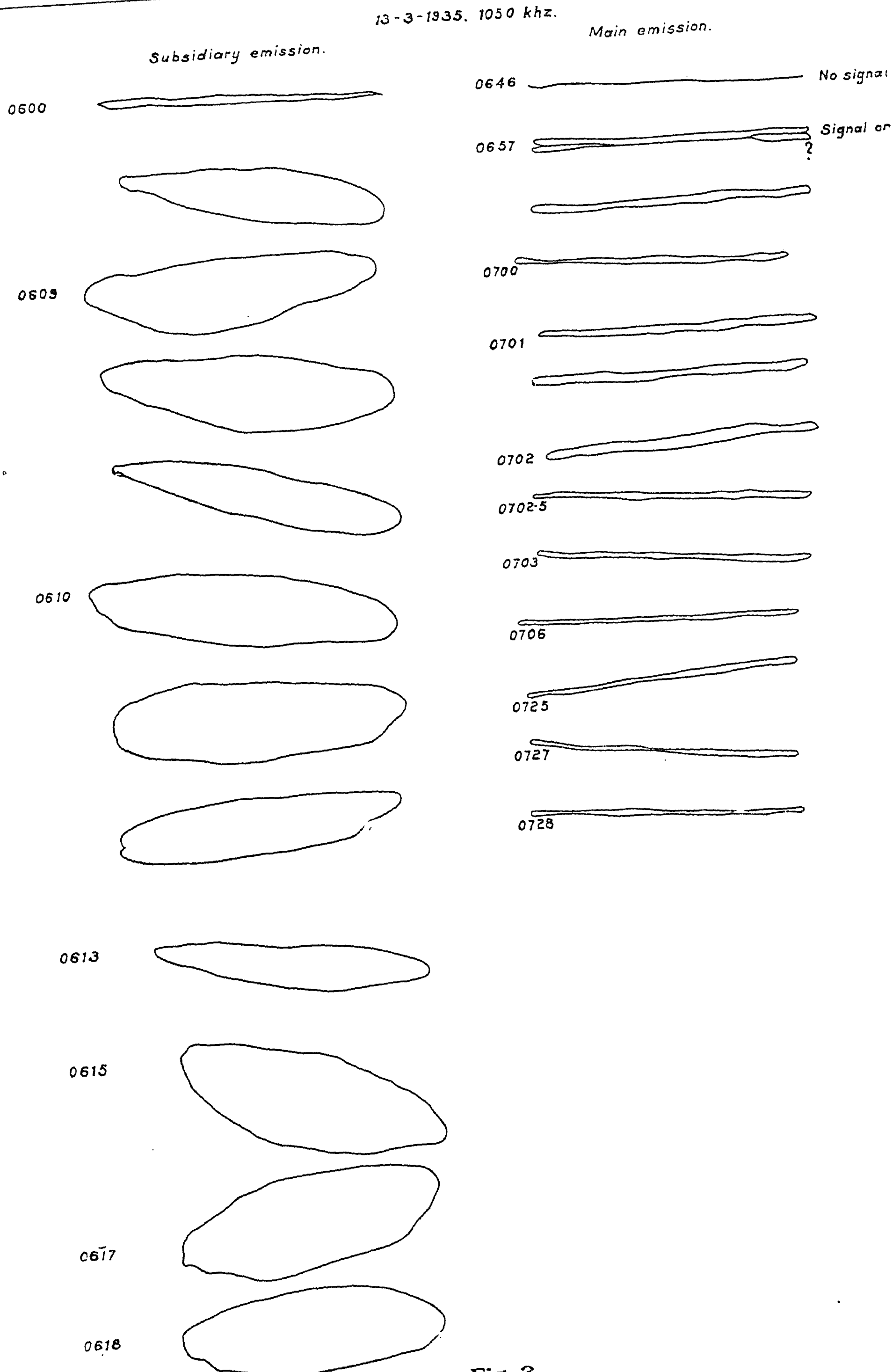

13-3-1935. 804 khz.
0655
0656
0657
0658
0700
0700
0700+
0702
0705
0706
0708
0710
Signal very weak.
0725
Signal very weak.
0726
Tilted

Fig. 2.



13-3-1935. 1050 khz.
Subsidiary emission.
Main emission.
0600
0605
0610
0613
0615
0617
0618
0646
No signal
0657
Signal or
?
0700
0701
0702
0702·5
0703
0706
0725
0727
0728


**Fig. 3.**

the vertical plates of its cathode ray oscillograph, while the horizontal plates were connected in common to the output of the local 1 khz fork apparatus; the resulting image on the screen was quickly traced by hand on a piece of clear tracing paper. Observations were hampered considerably by a rather unexpected source of trouble in the form of a continuous current motor used for pumping water. The announcements could not be made out at all.

The test oscillator modulated at 1 khz from a local tone generator was used in gaining experience in adjustment.

The pattern on the screen was, in general, a somewhat distorted ellipse on both 804 and 1050 khz; neither its shape nor its size was constant for more than a few seconds at either frequency (Figs. 2 and 3). The variations were more pronounced and rapid at the higher frequency than at the lower, particularly on 12th morning. In view of the location of the two transmitters at the same site in Scotland and the accuracy and high stability of the frequencies of the Institute and the NPL forks, the above would indicate that the variations in the figures observed on the oscillograph screen were due to the ionospheric transmission path in respect of intensity and of phase, that is, path difference. The local 1 khz voltage across the horizontal plates of the oscillograph with the 1050 khz receiver output across its vertical plates was replaced by the output from the 804 khz receiver; but the signals were so feeble that no clear diagram was obtained on the screen. The modulating frequency for the subsidiary emissions earlier in the morning on 13th March differed from that of the main emissions by only a few points in a million or less.

In spite of the distance of Bangalore from the transmitters and of the severity of electrical disturbances, more satisfactory observations and even measurements would probably have been possible if the programme of transmission had started about an hour earlier. Alternatively, modulation of some of the short wave transmitters might have enabled useful observations notwithstanding severe fading at these hours.

At the southern end of Bangalore, about 4 miles from the Institute Mr. N. Srinivasa Row "listened in" on 1050 khz using the excellent super heterodyne receiver owned by Sir M. N. Krishna Row. Atmospheric disturbances and fading were present but little of any "man made" disturbances. The announcements could be made out but somewhat incompletely. The 1 khz emission was heard; but as the morning proceeded, the signal got weaker; after about 0730 IST, nothing came out of the receiver except disturbances.

Grateful thanks are due to Dr. E. H. Rayner of the National Physical Laboratory, Teddington and present Chairman, Commission 1, Standards, of the URSI for kindly forwarding all relevant information and literature relating to the transmissions and to apparatus arrangements; to Mr. Evans of the Gramophone Company and to Mr. K. S. Ramamurthy for kindly lending the necessary broadcast receivers for the tests; and to Mr. N. Srinivasa Row for his accurate report of what he heard.

The apparatus arrangements and the observations were all made by Messrs. B. V. Baliga, T. D. Chatterji, T. Krishnaswamy Rao, S. N. Mukerji, K. Raghunatha Rao and T. V. Rama Murthy of the Electrical Communication Engineering Section of the Department of Electrical Technology of the Indian Institute of Science, Bangalore.

Indian Institute of Science,
Bangalore,
*March* 15, 1935.

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## Densities of Aqueous Solutions of Formaldehyde between 20° and 40°.

AUERBACH AND BARSCHALL[1] have determined the densities of formaldehyde solutions in water at 18°. As these solutions of different concentrations are now extensively used in photography in India, their densities have now been determined at temperatures between 20–40°. Thus, with the aid of an accurate hydrometer, the data given in Table I can be readily employed for determining the concentration of a given solution of formaldehyde at the usual laboratory temperatures in India.

For these determinations pure formaldehyde gas was obtained by passing a current of pure nitrogen over trioxymethylene contained in a retort heated to 180°. The gas was absorbed in distilled water kept in an ice bath and the most concentrated solution containing 42 per cent. of formaldehyde by volume was obtained. The amount of formaldehyde in the solution was estimated by the usual iodine method.

Densities were determined by a specific gravity bottle (Regnault type) which was

kept for fifteen minutes in a thermostat maintained at any desired temperature to within ± 0·02°. The balance weighed correctly to 0·1 mgm. and the method of double weighing was employed, correction being applied for bouyancy. A set of standard weights with N. P. L. certificate was used.

The results obtained are shown in Table I.

TABLE I.

*Densities of aqueous solutions of formaldehyde in terms of the density of water at 4° C.*

| Grams of formaldehyde in 100 c.c. sol. | $D_{20}$ | $D_{25}$ | $D_{30}$ | $D_{35}$ | $D_{40}$ |
|---|---|---|---|---|---|
| 2·76 | 1·0065 | 1·0054 | 1·0037 | 1·0020 | 1·0001 |
| 6·3 | 1·0167 | 1·0152 | 1·0136 | 1·0115 | 1·0097 |
| 11·55 | 1·0320 | 1·0303 | 1·0284 | 1·0263 | 1·0242 |
| 14·43 | 1·0403 | 1·0385 | 1·0365 | 1·0344 | 1·0321 |
| 19·3 | 1·0552 | 1·0531 | 1·0510 | 1·0486 | 1·0462 |
| 25·26 | 1·0703 | 1·0681 | 1·0658 | 1·0633 | 1·0606 |
| 30·9 | 1·0859 | 1·0835 | 1·0808 | 1·0782 | 1·0754 |
| 37·35 | 1·1013 | 1·0987 | 1·0961 | 1·0933 | 1·0904 |
| 41·43 | 1·1126 | 1·1099 | 1·1071 | 1·1042 | 1·1019 |

Gujerat College, S. N. DATAR.
Ahmedabad,
February 26th, 1935.

[1] Arbeaten aus dem Kaiserlichen Gerandheit samte.—*Zweiundzwanzigster Band*, 1905.

## Culture of Micro-Organisms on Cellophane Membrane.

IN the course of our studies on the mechanism of nitrogen fixation, it was found necessary to obtain considerable quantities of bacterial (azotobacter) growth free from the solid constituents of the culture media. By covering the solid medium with cellophane membrane, it was thought that the crystalloidal constituents comprising the greater portion of the nutriment, would permeate through the membrane and be made continually available to the growth of the bacterium while the solid medium underneath would, as usual, serve as the reservoir of nutrients and water.

The experimental technique consisted in covering the surface of the solid medium (after setting in a petri-dish) with a sterile strip of moistened Cellophane, so that the membrane was in intimate contact with the surface of the medium. (Cellophane supplied by the British Cellophane Company is used and it could be sterilised by heating it in an autoclave at 15 lbs. pressure for 15 minutes). The dish was inoculated in the usual manner. The organisms grew quite well on the media and the growth was found practically as satisfactory as the growth on plain, uncovered media. When sufficient growth had occurred, the membrane was lifted out of the dish and the bacterial growth easily recovered from the membrane.

The technique has now been successfully extended to other ærobic organisms. Attempts are also being made to apply the method to strict anærobes and to such parasites as normally grow only in association with their hosts.

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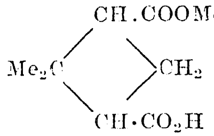
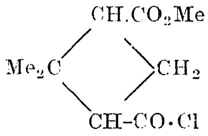
March 9th, 1935.

## Synthesis of Pinononic Acid.

PINONONIC acid was obtained for the first time by Wagner and Ertschikowski[1] by the oxidation of α-pinene which contained some verbenone or verbenol, and later on Kerschbaum[2] and Blumann and Zeitschel[3] got the same by oxidising verbenone. Fromm and Autin[4] obtained the same acid by the oxidation of olibanol the constitution of which is not yet definitely known. The establishment of the constitution of verbenone, depends entirely on the synthesis of pinononic acid. This has now been achieved in the course of our attempts to synthesise pinene and verbenone starting from norpinic acid.

*trans*-Norpinic acid prepared according to the method of Kerr[5] with slight modifications, was converted into the *cis*-anhydride in an yield of 80-85 per cent. of theory by heating it with acetic anhydride in a sealed tube at 190-200°. This on being treated with an equimolecular quantity of sodium methoxide in methyl alcohol gave the sodium derivative of *cis*-norpinic acid monomethyl ester (I) in almost quantitative yield.


I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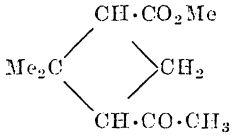
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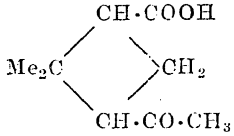
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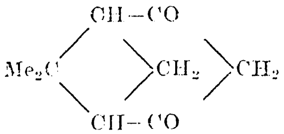
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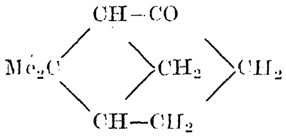
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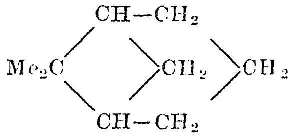
VII

The acid chloride (II) prepared from the mono-acid (I) with thionyl chloride, gave on treatment with one molecule of zinc-methyl-iodide, pinononic acid methyl ester (III) b.p. 130-135°/14 mm. obtained previously by Wagner and Ertschikowski[6] by esterifying the acid obtained from pinene by oxidation. This ester has been hydrolysed by alcoholic potash to pinononic acid (IV) m.p. 129°: semicarbazone, m.p. 209°.

Work on the conversion of methyl pinononate (III) into "ketonopinone" (V) by the elimination of a molecule of methyl alcohol is in progress which it is expected on reduction will yield nopinone (VI) and nopinane (VII).

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K. GANAPATHI.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
*April* 2, 1935.

[1] *Ber.*, 1896, **29**, 881.
[2] *Ber.*, 1900, **33**, 890.
[3] *Ber.*, 1913, **46**, 1194.
[4] *Ann.*, 1913, **401**, 256.
[5] *J. Am. Chem. Soc.*, 1929, **51**, 614.
[6] *Loc. cit.*

## Aerial Roots in Sorghum.

THE grain sorghum plant is usually single headed. When the head develops and gets weighty the plant supports itself on roots formed from the nodes immediately above the ground. Nodes up to four may usually function in such effective root production, though occasionally (according to vigour and closeness of the internodes) the number might go up to even ten. With the setting of the grains and the drying up or falling off of the lower leaves, ærial roots appear. In some cases such roots pierce through the persistent leaf sheaths. Their emergence is marked by knobs on the sheath surface. To determine the effect of the leaf sheath in such root formation 50 plants in the local Peria Manjal variety of sorghum were de-sheathed when 50 days old, with 50 other plants for a control. Observations on the emergence and distribution of ærial roots were made at intervals. Five days after de-sheathing 39 plants so de-sheathed started to develop roots, whereas only 4 in the sheaths-intact group showed such activity. After a month, in the 50 plants of the sheaths-intact group, 4 plants developed no ærial roots, 30 developed them in the first node above the ground, 14 in the first two nodes, 1 in three nodes and 1 in four nodes. In the de-sheathed group all developed roots, 11 of them in two nodes, 32 in three nodes and 7 in four nodes (*vide* Fig. 1). The

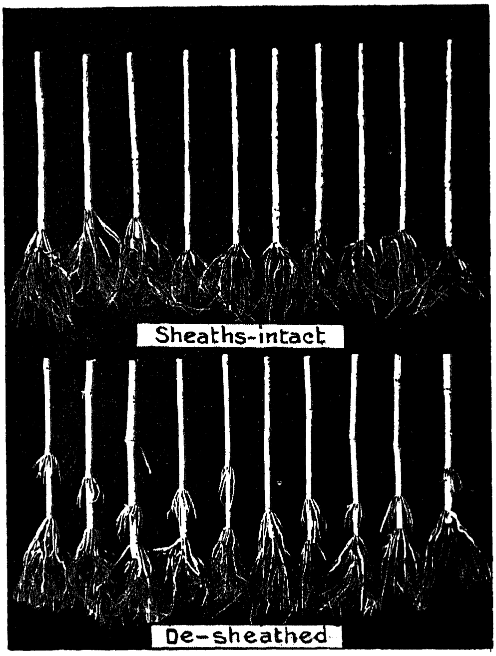


**Fig. 1.**

top nodes got stimulated consequent on de-sheathing, a condition brought about in nature through a natural slackening of the grip of the leaf sheath on the node and the need of the top-heavy plant for ancillary support.

Though the grain sorghums do not tiller like other cereals, still in certain years of abnormal rainfall and untimely opulence, there is a tendency for some of the dormant buds in the axils to give out side shoots that develop small ear-heads. The angle that these ear-heads make with the main stem coupled with the slackening of the hold of the leaf sheath, often results in the basal internodes of the side shoots being stimulated into root production. These roots develop rapidly and clasp the stem and thus afford security to the side shoots (*vide* Fig. 2). This close clasp is made efficient by the marked flattening of such clasping roots.

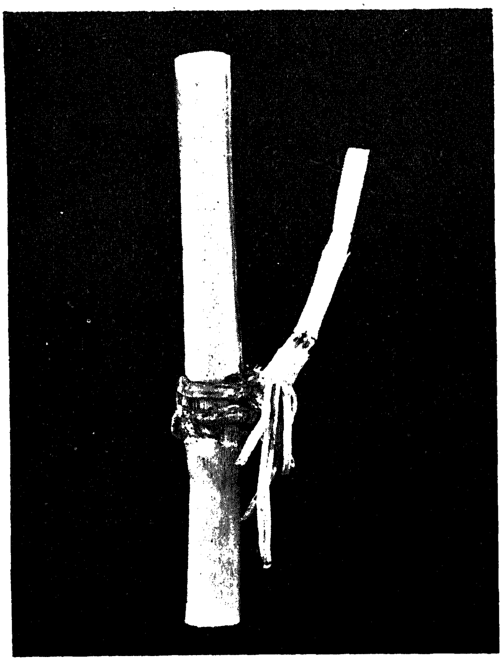

**Fig. 2.**
Clasping roots of side shoot.

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V. PANDURANGA RAO.

Millets Breeding Station,
Coimbatore,
*March* 14, 1935.

## Occurrence of *Psilotum*, Sw. in the Punjab.

THE genus *Psilotum*, Sw. is a very widely distributed one but is confined mostly to the tropical parts of the world.[1] There are only two of its species recorded. One is *Psilotum complanatum* Sw. and the other is *Psilotum triquetrum* Sw. The former species has not so far been observed in India. The latter is generally considered to occur mostly in Assam and Bengal. The two fairly old accounts of Prain[2] and Dalgado[3] and a private information from Royal Botanic Gardens, Calcutta, however, prove that the occurrence of the plant in this country is not so restricted. Specimens have also been collected from places in Southern India, Central Provinces, Bombay, United Provinces, etc. It would be of some further interest to point out that the distribution of this plant even extends to the Punjab—a region fairly removed from the tropics. According to the authorities of the Herbarium, Forest Research Institute, Dehra Dun, specimens of *P. triquetrum* have been collected and brought there from Upper Bashahr (a valley in Western Himalayas) besides from places in areas already mentioned. In the summer of 1933, the writer, who accompanied the late Rai Bahadur Dr. S. R. Kashyap on a botanical excursion to Himalayas, came across a few plants of *P. triquetrum* at Sultanpur, a place in Kulu which is another valley near Bashahr. The plants grew on the ground among the thick and moist undergrowth of *Alnus* forest along the bank of the river Beas. Some more plants of the species were found by Mr. S. A. Chaudhuri, another member of the party, from about two miles away from the previous place, growing in a similar situation. No more specimens were met with by the party at any other place in the valley.

The writer's thanks are due to Mr. K. P. Biswas of Royal Botanic Gardens, Calcutta, and Dr. K. Bagchee of Forest Research Institute, Dehra Dun, for the information supplied in the present connection.

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Department of Botany,
University of the Punjab,
Lahore,
*March* 13, 1935.

[1] Baker, J. G., *Fern Allies*, 1887, **30**.

[2] Prain, D., "The Genus *Psilotum*, Sw. in India," *Journal Bombay Natural History Society*, 1893, **8**, 428.

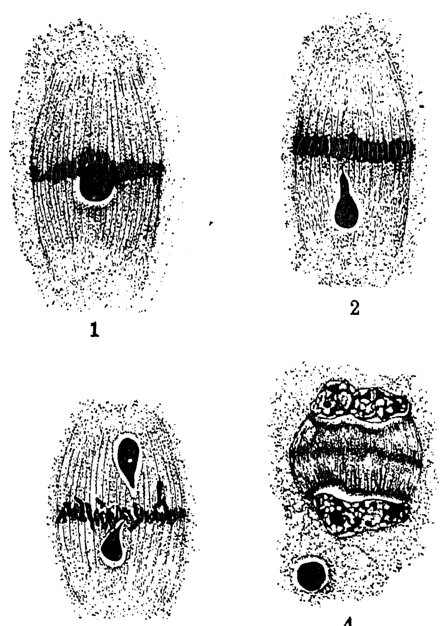
[3] Dalgado, D. G., "Note on *Psilotum triquetrum*," *Journal Bombay Natural History Society*, 1892, **7**, 544.

## Nucleolar Behaviour in the Somatic Mitosis of *Trichosanthes dioica* Roxb.

FREW AND BOWEN[1] working on a number of Cucurbitaceous plants observed that during somatic mitosis the nucleolus often persists up to the metaphase when it divides and the divisional products migrate to the poles. Similar behaviour of the nucleolus in higher plants has been previously noted by other investigators an account of which has been given by Frew and Bowen. In this note an account of the behaviour of the nucleolus as observed by us during somatic mitosis has been presented.

Simultaneously with the disappearance of the nuclear membrane the nucleolus is also lost sight of, but in some cases it is seen to persist up to telophase. Such nucleolus is generally found to lie entangled within the chromosomes after the disappearance of the nuclear membrane. The volume of the nucleolus becomes much reduced. The nucleolus is usually round at this stage.

At the time of orientation of the chromosomes at metaphase the nucleolus also moves along with them and lies more or less



1 2 3 4

× 2,000

at the centre of the spindle (Fig. 1). Very soon after its orientation at the central region of the spindle, the nucleolus tries to move bodily to one of the poles and assumes different forms. This is noted before the anaphasic separation of the chromosomes. As the nucleolus moves further away from the chromosomes a very thin thread-like process may be seen connecting the nucleolus with the chromosomal region of the spindle (Fig. 2). During the migration of the nucleolus to the pole it appears as pear-shaped body which gradually rounds off and becomes spherical. In almost every case the nucleolus seems to move to either of the poles without division, but in a very few instances, however, division and subsequent migration of the divisional products have been noted. In these cases the nucleolus is caught just in the central region of the spindle at metaphase and becomes elongated in the direction parallel to its longitudinal axis and undergoes constriction at the central region. Gradually the central region becomes attenuated and the two daughter halves are pulled apart. The connecting process ruptures and finally the two daughter nuclei separate. The separated halves are not always identical (Fig. 3). The nucleolus as it reaches the pole is ultimately cast out of the spindle area and lies at some distance from it.

The anaphasic movement of the chromosomes does not take place until the nucleolus has reached its final position. During anaphase and telophase the nucleolus is found to lie in the position already attained by it during the metaphase. It remains in the same position without showing any signs of degeneration up to the reconstruction of the daughter nuclei. In the daughter nuclei new definitive nucleoli are organised. These newly constructed nuclei do not appear to have any connection with the cast out nucleoli which always remains extra-nuclear (Fig. 4). Mostly the cast out nucleolus at this stage does not seem to show any appreciable change, but in some preparations a dull appearance is noted. Shortly after this the extruded nucleolus suddenly disappears in the cytoplasm without leaving any trace. The cytoplasm appears to be quite homogeneous and no trace of the nucleolus is seen.

The mode of division and the migration of the divisional products of the nucleolus has been explained in various ways. The theory of fibrillar contractility does not appear to explain the polar migration of the nucleolus because as previously pointed out by other investigators, the nucleolus does not show any fibre attachment and still it moves earlier than the chromosomes. The

"Stemm-theorie" also fails to explain the precocious migration of the nucleolus to the pole. Frew and Bowen are of opinion that "the spindle area represents a region in which are localised those forces of whatever kind which are responsible for the anaphasic movements." The equatorial orientation and subsequent division of the nucleolus is merely a necessary result of the more or less incidental catching of the nucleolus in the spindle region. On this hypothesis the migration of the nucleolus to one of the poles as observed by us in *Trichosanthes dioica* could be explained. In metaphase the nucleolus lies a little above or below the equatorial plate and as such the "forces" acting on the nucleolus being greater on one side than in the other, the nucleolus is bodily pushed aside and migrates to one of the poles. In those cases where the nucleolus lies in the centre of the equatorial plate the forces at work being equal on both sides of it, the nucleolus is divided equally into two.

I. Banerji.
M. C. Das.

Department of Botany,
Calcutta University,
*February* 20, 1935.

[1] Frew, E. P., and Bowen, R. H., *Quart. Jour. Micr. Sci.*, 1930, pp. 197-240.

## Chromosome Numbers in *Sesbania grandiflora* Pers.—The Agathi Plant.

*Sesbania grandiflora*, Pers. is a leguminous soft-wooded tree commonly grown to serve as a post, on to which betel vines are trained. Its leaves provide light shelter. In the early stages young twigs with leaves are cut and fed to cows. The tender leaves are consumed as greens. The tree grows to a height of about 20 feet and its grand flowers are about 10 cm. long.

The chromosomes in this legume were studied in two varieties: (1) the common pole variety about 15–20 feet high with white flowers about 10 cm. long, flowering at definite times, and (2) the short, early branching, red flowered variety about 7–8 feet high, with flowers about 8 cm. long, with frequent flowering.

Divisions were obtained in pollen mother cells in buds of about ½ cm. long and of pollen grains in buds of 2 cm. length. Aceto-carmine smears as well as permanent sections stained in Gentian-Violet-Iodine were examined. Counts in both pollen mother cells and pollen grains gave 7 (seven) as the haploid number. The chromosome numbers in both varieties were found to be the same. In the pollen grains the chromosomes were found to be larger than in the pollen mother cells.

The chromosome complement was found to be made up of 2 long, 2 medium and 3 small. In the two long ones chromosome was slightly longer than the other, so also in the two mediums (Fig. 1). A median

**Fig. 1.** ×3500

attachment constriction was found in the longer and a sub-median in the shorter of these chromosomes. All the shorts had median attachment constrictions. The segregation was normal and regular. In the pollen mother cells one of the long chromosomes was found to be sometimes retarded (Fig. 2).

**Fig. 2.** ×3100

Kawakami (1930) records 16 (sixteen) as the haploid number in *Sesbania aculeata*, Pers.

N. Krishnaswami.
G. N. Rangaswami Ayyangar.
Millets Breeding Station,
Agricultural Research Institute,
Coimbatore,
*March* 28, 1935.

## The Fish and Fisheries of the Punjab.

IN your issue of December last a correspondent attacks a series of short articles entitled as above which appeared in the *Statesman* on October 28th, and November 4th and 11th, 1934.

He appears to be under the impression that the above articles were a criticism on the Department of Agriculture and the Fisheries Research Officer. Let me assure him, here and now, that there was no such intention on the writer's part. If criticism or attack there was, it was levelled at Government for adopting a "drift" policy in regard to what should be an important department, responsible for a vast food supply of the province.

The writer in *Current Science* is, I presume, himself a scientist and, as such, should pride himself on the meticulous accuracy to detail and observation of facts from which his deductions are made. Half truths should be anathema to him, and yet what do we find? He quotes extracts from the articles in question to show that the writer advocates the closing down of all research, and carefully omits the passages which lead to the suggestion and go to the root of the whole trouble, *viz.*:—*Stop playing with research and wasting public funds. If you cannot do otherwise than play, then stop it entirely.*

The following extracts speak for themselves. I give them in parallel columns:—

| FROM *CURRENT SCIENCE*. | FROM THE *STATESMAN*. |
| --- | --- |
| "The correspondent of the *Statesman* suggests .....that the research work on fisheries in the Punjab should be closed down 'until such time as adequate funds are available to place it on a proper footing, with a pisciculturist from Europe or America at its head'. This is just the kind of advice a civilian administrator of a scientific department would, in a spirit of despair, tender to the Government when its financial resources might be temporarily dislocated; but the viewpoint of a scientist would precisely be the opposite." <br> *Again*, "The advocacy of the policy of closing down research departments of Government industries such as is advocated by the correspondent of the *Statesman*....can only be accepted on the responsibility of placing the country in a state of perpetual dependence on foreign products." | "Can the proverbial two men and a boy, with a tank to play in, constitute the research of a vast subject like the fisheries of a province? That research is essential no one can deny, but why play at it?" <br> *Again*, "If....research cannot be carried on in a business-like way, with a proper staff and facilities, it should be closed down altogether till better times. To continue to play with it is a useless expenditure of public funds...." <br> *Again*, "It has already been said that research is absolutely essential if we are to get the best results, but research must be undertaken seriously and not played with. If this cannot be done it would be better to close it down entirely until such time as adequate funds are available to place it on a proper footing with a pisciculturist from Europe or America at its head." |
| 2. "According to the correspondent of the *Statesman* "when a Research Officer was appointed in 1920 it was confidently hoped that the branch would develop, but 14 years have elapsed and except that he has access to a fine laboratory, research, as such, is no further advanced." The Research Officer alluded to is a young inexperienced graduate of the Punjab University and he was expected to work miracles without special training and necessary guidance by the head of the department." | 2. A layman might be forgiven for asking how long a scientist remains "young and inexperienced"? The Officer in question took his M.Sc. (1st Class) in Zoology, in 1916 or 1917. He then spent a year or so in the Law College and was Professor of Zoology in the Aligarh College before joining the Fisheries Department nearly 15 years ago. For the last $2\frac{1}{2}$ years he has had the advantage of working under two eminent scientists, the Government Entomologist and the Director of Agriculture. Under their "special training and necessary guidance" has fisheries research progressed one iota in that time? |

I attach no blame to the Research Officer as it has been very much a case of a carpenter without tools, but I would again reiterate *do not play at research*.

Alluding to the introduction of trout in the hill streams the writer tells us that it is dangerous to try experiments in introducing exotic species. He says:—"Any interference by clumsy experiments is an act which few trained and experienced scientists would lightly undertake." He, however, omits to mention that the experiment was undertaken in waters in which only one indigenous species exists, and that one of small economic value. On the other hand has not the question of introducing trout into the Ravee River *at Madhopur* (where mahseer and other indigenous varieties abound), been recently mooted, and by scientists? The question was put to me by one in all seriousness. He may, of course, have been untrained and inexperienced.

In the articles in the *Statesman* the suggestion was made that the Research Section should remain under the Agricultural Department but that the Administrative

Branch should be placed under the Game Warden. The latter part of the suggestion found an echo at the recent All-India Conference for the Preservation of Wild Life.

To put the whole case in a nutshell. If the Director of Agriculture is to administer the whole Fisheries Department as well as his own he should be given the staff and the facilities with which to do it. To expect a busy man like him to give the requisite time to another department is to ask for the superhuman.

On the other hand if D.D.A.'s and E.A.D.A.'s are to wander about the riverain tracts doing the work of Fisheries Officers they must have a good deal more time on their hands than one imagines. If they have enough work of their own to keep them employed then they obviously cannot do justice to the fisheries, so why try ?

"INTERESTED."

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[IN the light of the remarks made by our correspondent "Interested", we have re-perused the Editorial on "Inland Fisheries in India"[1] and also the short articles published in *Statesman* on October 28th and November 4th and 11th. We were concerned only with the broad principles and general problems of the Fisheries in India, and made certain constructive proposals for their improvement. We had no persons to defend and no interests to support. We had absolutely no motive in concealing "truths". However "Interested" tries to point out that some of our statements misrepresent the intentions and purposes of the writer of the articles in the *Sunday Statesman*. We maintain that our Editorial is perfectly honest and disinterested.

On reading the articles on "Fish and Fisheries of the Punjab" published by a "correspondent" in the *Statesman*, we can hardly resist the conclusion that the writer of these articles possessed an inside knowledge of the working of the Department, his main object was to convince the local Government of the advantage and desirability of placing the administrative branch of the Fisheries Department under the Game Warden,—a newly created post,—and for this purpose the articles were cast more in the nature of a propaganda, suggesting that the Fisheries Department could not function efficiently under the existing arrangement. We are surprised to learn from "Interested" that a fundamentally wrong suggestion of this kind, in connection with the development of Fisheries in India, has recently been made at the "All-India Conference for the Preservation of Wild Life" which met at New Delhi not long ago, and we hope to be able to review in these columns the proceedings of this assembly as soon as they are available to the public.

We stress that the following considerations are imperative for the satisfactory progress of research work on Fisheries in India:

(1) The Department should be staffed by scientists suitably trained for Fisheries work possessing knowledge of local conditions. (2) The Head of the Department, being a scientist, should provide a carefully planned programme of laboratory and field work to his assistants whom he must be in a position to guide and control. (3) The Department should receive adequate financial support from the Government.

"Interested" points out that he advises to the Punjab Government is "stop playing with research and wasting public funds: if you cannot do otherwise than play, then stop it entirely". Our advice is "don't permit research to be played with. If you know your job, you can make the limited grants go a long way. Impress upon the mind of Government that research is revenue. Demonstrate this fact by your results. We don't want the 'doctors' of a correspondent to come and tell us that research is good but close it down, if you cannot provide sufficient funds or import experts from America and Europe". Manifestly the remedy suggested by the correspondent to the *Statesman* whom "Interested" has set out to support, is far more drastic than the disease, and no one who is acquainted with the history of scientific research will support the views of either of these writers.

The Punjab Government has been spending money on Fishery Research and if it is being played with, the causes for such a condition are (1) the research officer possessed no training in Fisheries at the time of his appointment, (2) he was not furnished with any organised programme of work, and (3) the non-scientific head of the Department could neither advise nor guide research work. Under such unpropitious circumstances neither the length of the service of the research officer, nor his early academic qualifications in general zoology and not in *fisheries*, could make him an experienced expert for fisheries research. The Government Entomologist and the Director of

Agriculture are undoubtedly eminent in their own restricted spheres of work, but cannot reasonably claim to direct investigations in Fisheries, a province entirely out of their beat. It is not therefore surprising that Fisheries Research in the Punjab has not advanced even under the guidance of these scientists.

It occurs to us that the Punjab Government which provides money for fishery research and maintains a research officer should have invited a Fishery expert—for instance the Director of Fisheries, Madras, or the Director of the Zoological Survey of India or his nominee,—to draw up a programme of work for the officer and to supervise it periodically, when the Government discovered that it could not obtain such assistance from the non-scientific head of the Fisheries Department. It is inevitable that research under these circumstances should drift into play: and most assuredly the remedy is not to "stop". Use all the available forces and material. Then ask for more. Fisheries research is both a field problem and laboratory work and in the initial stages, a great deal of work is capable of being accomplished even with moderate equipment provided there is adequate knowledge and generous enthusiasm for discovering and solving problems. Recently we have had an occasion to refer in these columns[2] to the progress made by a small Fisheries Department in the Bombay Presidency and it is very gratifying to learn that without the expert advice of pisciculturists from America or Europe, this Department has during the last two years achieved great progress in the fish trade in Bombay. In order to improve its fisheries, the Punjab Government should place the Fisheries Department under a local expert possessing the requisite qualifications for advising the Government on scientific and administrative problems and for guiding and controlling the research work of the officers.

"Interested" betrays lack of knowledge of Indian fish fauna, when he remarks that trout introduction "was undertaken in waters in which one indigenous species exists, and that one of small economic value". We have not found anywhere the results of the proper survey of fish fauna of these waters, but, judging by the conditions in streams generally elsewhere in India, it seems rather a bold suggestion to make. Usually there are numerous species of fish of varying sizes in almost every stream and introduction of an exotic species is bound to upset the ecological balance of nature. It is therefore highly desirable to investigate the local fauna and its reaction to the introduced species before undertaking an experiment on a large scale.

It is unfair to the Fishery Research Officer, Government Entomologist and Director of Agriculture, the Punjab, to continue this correspondence under a *nom-de-plume*. The tender solicitude which "Interested" manifests in defence of the statements made by a "correspondent" to the *Sunday Statesman* marks him out as Dr. Jekyll supporting Mr. Hyde.—ED.]

[1] *Curr. Sci.*, 1934, **3**, 227-231.
[2] *Curr. Sci.*, 1934, **3**, 214.

## Showers of Fish.

LAST year attention was directed to almost all the recorded instances of the "Rains of Fishes in India"[1] and after considering various explanations of the unusual, though not uncommon, phenomenon it was shown that the fish are probably sucked up from a pond or river by a water-spout and fall to the ground when the water-spout collapses. Mr. P. O. Matthai has now directed my attention to an interesting paragraph, entitled "Falling Fish" in Carey's[2] *Good Old Days of Honorable John Company*, which is very significant in this connection. It runs as:

"The phenomenon of fish falling from the clouds in the rainy season, however incredible it may appear, has been attested by such circumstantial evidence, that no reasonable doubt can be entertained of the fact. The first instance we see recorded is that of a fall which happened at the Nokulhutty Factory at Dacca, and another shower took place near the Surbundy Factory, Furreedpore, both in 1830. Since which several instances are noticed in the papers of later dates. This phenomenon is of easy explanation. The fishes, 8 or 10 inches in length, are swept up by whirlwinds from ponds and held suspended in the rain cloud until they are thrown down in showers. The curious part is, that the fishes are found on the ground alive and uninjured."

A detailed account of the Nokulhatty Factory fall, referred to in the above quotation, was published by Princep[3] but now it is learnt that a similar shower of fish occurred at "Furreedpore" in the same year and that several other instances were reported in local press during the years following 1830. Unfortunately these accounts are not available now.

It may be recalled that in my recent

article reference was made to a popular Hindu belief in Bihar regarding the sucking up of water from the earth by one of Lord Indra's elephants with a view to show the frequeney of waterspout formation in that area due to meteorological conditions. This mythological belief had nothing to do with the scientific investigation of the causes of the phenomenon by Dr. Sen and myself as misrepresented by a writer[4] in *Nature* of September 22, 1934 (p. 454).

SUNDER LAL HORA.

Zoological Survey of India,
Indian Museum, Calcutta,
*March* 22, 1935.

[1] Hora, S. L., "Rains of Fishes in India," *Journ. Asiat. Soc. Bengal*, (N. S.), 1933 (1934), **29**, 95-110.

[2] Carey, W. H., *The Good Old Days of Honorable John Company* (Calcutta 1907), **2**, 361.

[3] Princep, J., "Fall of Fish from the Sky," *Journ. Asiat. Soc. Bengal*, 1833, **2**, 650-652.

[4] Anon, 'Showers of Fish,' *Nature*, 1934, **134**, 454.

## Panthachuk (Srinagar, Kashmir) Rhyolite.

IN an issue of *Current Science*[1] a rhyolite was described from the Panjal Trap formation in the neighbourhood of Srinagar. In a subsequent issue[2] W. D. West, on the basis of a communication from D. N. Wadia, has thrown doubt on the validity of the discovery. He states that this particular occurrence is ordinary Panjal Trap (*i.e.*, andesite or basalt) which has been silicified.

| | Panthachuk Rock (S. G. 2-63) | Average by Daly[3] | Rhyolite from Yellowstone National Park[4] |
|---|---|---|---|
| $SiO_2$ | 73·59 | 72·77 | 75·34 |
| $TiO_2$ | 0·35 | 0·29 | .... |
| $Al_2O_3$ | 10·94 | 13·33 | 12·51 |
| $Fe_2O_3$ | 0·32 | 1·40 | 0·42 |
| $FeO$ | 2·98 | 1·02 | 1·55 |
| $MnO$ | 0·04 | 0·07 | 0·07 |
| $MgO$ | 0·23 | 0·38 | 0·32 |
| $CaO$ | 1·80 | 1·22 | 1·07 |
| $Na_2O$ | 5·05 | 3·34 | 3·31 |
| $K_2O$ | 3·81 | 4·58 | 4·17 |
| $H_2O$ | 1·46 | 1·50 | 0·86 |
| $P_2O_5$ | .... | 0·10 | .... |
| $SO_3$ | .... | .... | 0·42 |
| TOTAL | 100·57 | | 100·04 |

No reasons have, however, been given for this statement.

The petrographic description of the rock given in the previous note is sufficient to prove that the rock is a rhyolite and not a "silicified" trap. My friend Dr. V. S. Dubey has now kindly analysed a specimen of the rock. The results of the analysis are given above. For comparison the average of 102 analyses of rhyolites by Daly and the analysis of a rhyolite, closely approaching the Panthachuk rock in chemical composition, are also given. It is obvious that the data regarding the Panthachuk rock are capable of only one interpretation, namely, that the rock is a rhyloite. The remarks of D. N. Wadia as quoted by W. D. West have no facts to support them.

NORM OF THE PANTHACHUK ROCK.

Quartz 29·31, Orthoclase 22·80, Albite 31·58, Acmite 0·92, $Na_2O.SiO_2$ 1·59, Diopside 7·71, Hypersthene 1·45, Ilmenite 0·61. Total 99·03.

K. K. MATHUR.

Geological Laboratory,
Benares Hindu University,
*March* 5, 1935.

[1] *Curr. Sci.*, 1933, **2**, 126.

[2] *Ibid.*, 1934, **3**, 234.

[3] *Igneous Rocks and the Depths of the Earth*, 1933, p. 9.

[4] J. E. Whitfield, *U. S. G. S. Monograph* 32, p. 126.

I THINK that Prof. Mathur has misunderstood the intention of the footnote. The nature of the rock described by Prof. Mathur and Mr. S. N. Wakhaloo in their letter to *Current Science* was never in question. It was quite clear from their description that it was a rhyolite. What Mr. Wadia took exception to was the impression given in the letter that acid volcanic rocks were fairly common around Srinagar, whereas according to him many of these rocks which at a first glance look like acid volcanic rocks, are really silicified basic volcanic rocks. Consequently in my footnote I used the words "in the main". Mr. Wadia is not now in India, but I am sure he did not question the nature of the particular rock described by Prof. Mathur and Mr. Wakhaloo.

Although these rhyolites may be quantitatively unimportant, nevertheless their discovery is of much interest; and the analysis given by Dr. Dubey adds further interest.

W. D. WEST.

# On the Development of the Neural Arch, rib-bearing process and the rib of the trunk vertebræ of a Perennibranchiata *Necturus maculatus*.

By Himadri Kumar Mookerjee and Suryya Kanta Das,
*Department of Zoology, University of Calcutta.*

According to Gadow[1] the neural arches of the trunk vertebræ of Perennibranchiata are formed from the cartilaginous basidorsals of either side, which eventually meet at the mid dorsal line to complete the neural arch. There is neither the supradorsal nor the neural spine. Subsequent authors like Schauinsland corroborated the statement of Gadow. Emelianoff[2] has recorded that in the mesenchyme stage, there is apart from basidorsals another aggregation of mesenchyme, which from its position and form reminds one very much of an arch. This additional aggregation is not retained long and soon disintegrates.

One of us[3] who worked on the development of the vertebral column of *Triton vulgaris* has stated that, corresponding to each vertebral centrum, the cartilaginous basidorsals are situated in the middle region and this cartilaginous arch is gradually deflected posteriorly. The cartilaginous basidorsals of either side do not meet at the mid dorsal line to complete the arch, but there is a third piece which should be called supradorsal. Corresponding to the anterior and posterior portions of each vertebral centrum the spinal cord is enveloped by a connective tissue arch which is curved not like the cartilaginous arch but forms two perpendicular side pillars with a third piece as a roof, the latter has two projections on either side to form the dorsal shelves in each vertebra. From the mid dorsal roof of the anterior connective tissue arch there forms a big neural spine. These anterior and posterior connective tissue arches become osseous without passing through the stage of chondrification. The connective tissue arches are narrower than the cartilaginous arches which project more on the lateral sides. Mookerjee for the first time recorded that the cartilaginous arch except the supradorsal, degenerates. The degeneration does not take place in the basidorsal as a whole, but cartilaginous cells together with the inner perichondrial layer degenerate, leaving behind the outer perichondrial layer which is converted into bone. If one goes through a series of transverse sections of the entire length of a vertebra at different stages, before and after the degeneration, he will find difference in the thickness of the connective tissue arch and the cartilaginous arch. Before the degeneration of the cartilaginous basidorsals, the connective tissue arches are much thinner than the cartilaginous arches, but after the degeneration of the cartilaginous cells and the inner perichondrial layer of the basidorsal has taken place, the thickness of the outer perichondrial layer becomes thinner than even the connective tissue arches. The supradorsal element retains its cartilage and will eventually be converted into a huge mass of bone.

Mookerjee[6] in collaboration with Chatterjee has shown the existence of anterior and posterior connective tissue arches in case of *Ophicephalus stolatus*. The same sort of connective tissue arches have also been shown by Mookerjee[7] in collaboration with Mukherjee in the cervical vertebræ of *Chrysemys marginata*. There is no degeneration of basidorsals in the above two cases of reptiles.

In case of *Necturus maculatus* we got the same sort of anterior and posterior connective tissue arches, and in between the two, there forms the cartilaginous basidorsals of either side with the intervention of supradorsal at the mid-dorsal line. The shape of the anterior and the posterior connective tissue arches are unlike that of the *Triton vulgaris*; have the shape of curved arches like the cartilaginous arch. The striking difference with *Triton vulgaris* is that, instead of slightly smaller than the cartilaginous arch they are bigger and there is no projection to form the dorsal shelves. The partly degenerated cartilaginous arches are almost identical like that of *Triton vulgaris*. In the same way as in the case of *Triton vulgaris* one can see in a serial transverse sections through any trunk vertebra other than the first four, the following structures in the serial order :—the anterior connective tissue arch, the cartilaginous thick arch and the posterior connective tissue arch (Figs. 1–3). A stage older than this where there has been a degeneration, the anterior and the posterior connective tissue arches are thicker than the degenerated cartilaginous arch in which the remaining outer perichondrial layer of the basidorsals, looks comparatively

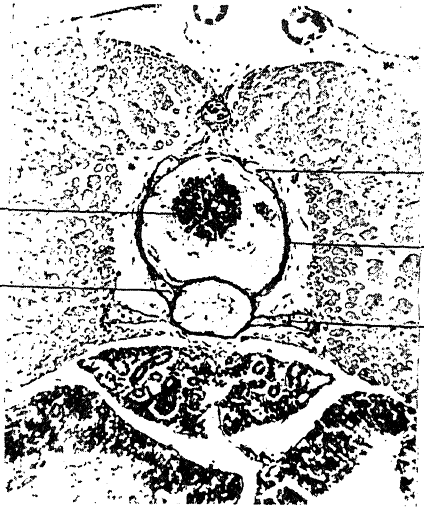


**Fig. 1.**

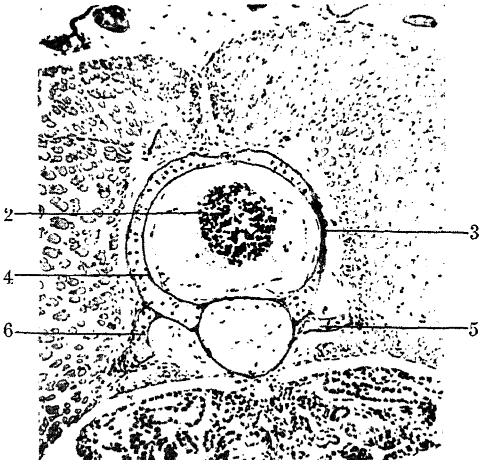


**Fig. 2.**

thinner than the connective tissue arches. These connective tissue arches together with the outer perichondrial layer of the cartilaginous basidorsals have now become osseous (Figs. 4–6). For the sake of comparison we have given the side view of three consecutive adult posterior trunk vertebræ (Fig. 7) and have marked those planes through which the transverse sections would have passed. Figs. 1–3 as one lot and Figs. 4–6 as another lot correspond more or less with the markings on the adult vertebræ.

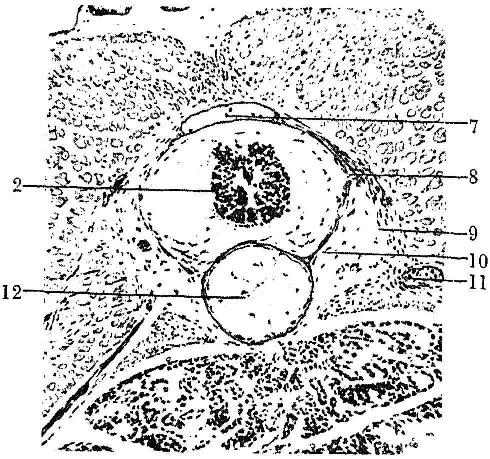


**Fig. 3.**

**Figs. 1-3.** Photomicrographs of serial transverse sections through different regions of a posterior trunk vertebra of *Necturus maculatus* at 38 mm. before the degeneration of basidorsal. × 37·3.

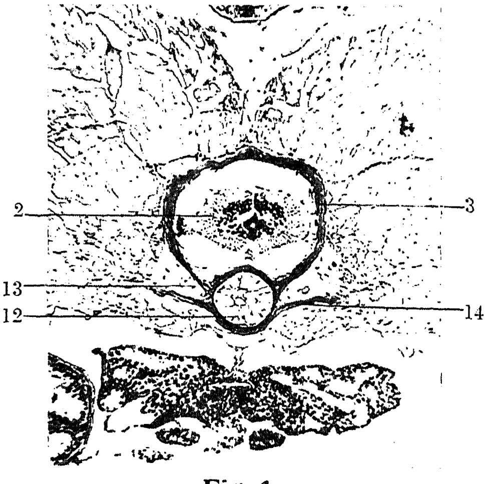


**Fig. 4.**

Here we like to suggest that instead of calling the anterior and posterior connective tissue arches even after they become osseous it is better to call them the anterior and posterior membrane bone arches.

Regarding the rib-bearing process and the rib of *Necturus maculatus* it was Göppert[8] who suggested that there is hæmal arch element (basal stump) attached to the lateral sides of the centrum. Each of these from the middle of its length sends off a dorsal process which he called the rib-bearer. This passes dorsally to the neural arch and laterally to the vertebral artery and then

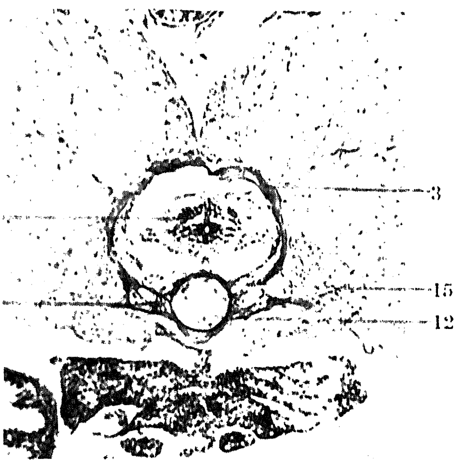


**Fig. 5.**

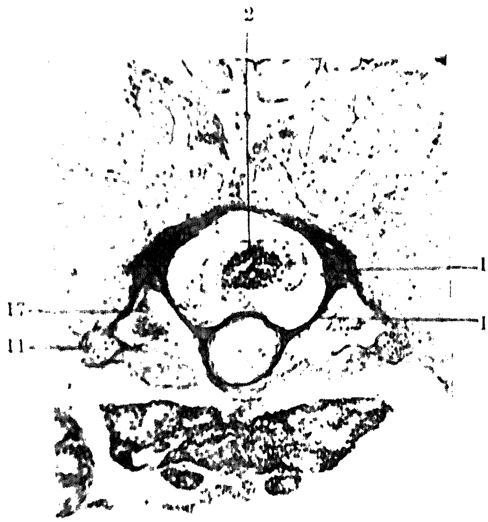


**Fig. 6.**

**Figs. 4-6.** Photomicrographs of serial transverse sections through different regions of a posterior trunk vertebra of *Necturus maculatus* at 48 mm. after the degeneration of basidorsal. × 37.3

continues dorsocaudally over the surface of the arch. The rib-bearer is separated from the cartilaginous arch by a connective tissue to start with, which ultimately becomes osseous. Further lateral to the rib-bearer the basal stump continues horizontally and the rib is a mere prolongation of this element. Still further lateral to this the rib is developed and a dorsal process of which extends towards the vertebra and becomes the dorsal head of the rib. This dorsal process is prolonged into a ligament which is attached by its other end to a mass of bony tissue

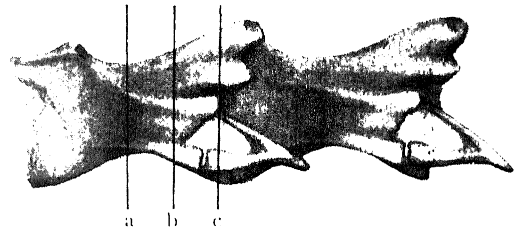


**Fig. 7.**

Side-view of two consecutive adult vertebræ of *Necturus maculatus.* × 2·6

*a, b, c* are the planes through which Figs. 1 to 3 and 4 to 6 have passed.

developed on the outer side of the rib-bearer (Fig. 8).

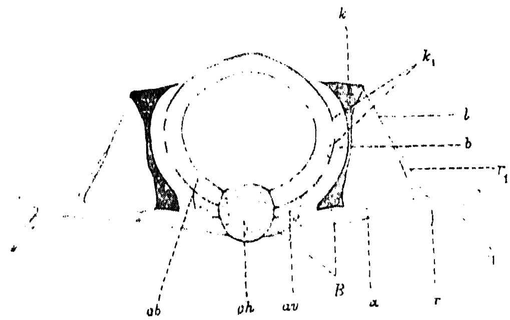


**Fig. 8.**

Transverse section through the trunk vertebra of *Necturus maculatus* at 43 mm. (after Göppert).

*ch.* Notochord; *ob.* Upper arch; *B.* Basal stump; *b.* Dorsal prolongation of the same; *r.* Rib; $r_1$. Dorsal rib process; *l.* Ligament connecting the same; *a.* Border between rib and basal stump; *k.* and $k_1$ Bony tissue; *av.* Vertebral artery.

According to Gamble[9] the mesenchymateous condition (which he calls as proton) of the rib and rib-bearer is made up of a larger number of cells which aggregate in contrast to the proton of parapophysis. The first cartilage to appear is the basal stump. Later the parapophysis is formed as a latero-dorsal outgrowth. The first cartilage of the rib appears distally and later mesially. The first cartilage of the rib-bearer appears at the side of the neural arch. Later, this grows ventrally and fuses with the distal end of the parapophysis, and also develops dorsocaudally over the outer surface of the neural arch. The proximal end of the rib is relatively high in the second and third vertebræ, *i.e.*, it is on a level with the base of the neural arch. The parapophyses of the vertebræ in which the rib is high do not lie in a horizontal plane, but extend dorsolaterally and approach the rib-bearer.

The rib-bearer and the parapophyses do not fuse until relatively late, while the rib becomes attached to the rib-bearer before the rib-bearer and the parapophyses come together. In the second and third vertebræ the capitular as well as tubercular heads of the rib become attached to the corresponding processes of the rib-bearer. In these vertebræ the parapophysis takes no direct part in the formation of the rib attachment apparatus. Here the rib is an independent element from the standpoint of its origin and the connection with the basal stump is done at a later stage. In the trunk vertebræ the rib is on a level with the middle of the centrum. Here, the capitular head of the rib attaches to the parapophysis and the tubercular head makes no connection with any process of the rib-bearer. The rib-bearer fuses with the distal end of the parapophysis and as growth takes place the distal end of the parapophysis extends laterally past this point of union (Fig. 9).

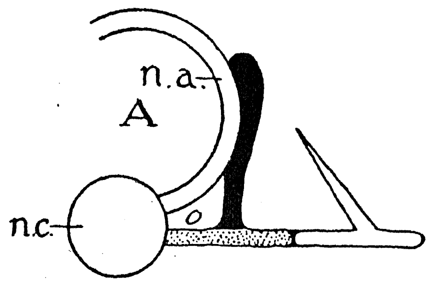


**Fig. 9.**

Transverse section through the trunk vertebra of *Necturus maculatus* (after Gamble).
*A.* Neural canal; *n.a.* Neural arch; *n.c.* Notochord.

Between the dorsal and ventral cartilaginous rods as well as the transverse processes and the two heads of the rib in the second and third vertebræ, procartilaginous cells persist which by proliferation bring about the elongation of the transverse processes. In the trunk vertebræ the head of the rib has no cartilaginous connection with the rib-bearer, so this provision just referred to is necessary only in the case of parapophysis.

Regarding the development of the rib-bearing process and the rib neither Göppert[8] nor Gamble[9] has given the correct statement. Both of them had no idea of the degeneration of basidorsal and the existence of the anterior and posterior membrane bone arches in each vertebra. Gamble[9] has given a figure (Fig. 24, page 558), in which he has faithfully represented the thin membrane bone arch but as he had no idea of its existence, so he could not identify it. In a trunk vertebra the first chondrification that take place regarding the rib and its associates is the basal stump which is on the lateral side of the centrum at the middle level (Fig. 1). Soon after this there forms another chondrification which starts from the outer side of the basidorsal almost at the base in a downward direction to meet the horizontal basal stump (Fig. 2). This downward piece of cartilage is the rib-bearing process or the diapophysis. The vertebral artery lies within the space enclosed by the rib-bearing process on the lateral side and the basal stump at the bottom very close to the centrum. Both Göppert[8] and Gamble[9] have stated and which have been represented in the figures given by them (Figs. 8, 9) that the rib-bearing process is situated along the side of the basidorsal and it reaches at a considerable height towards the dorsal side. As a matter of fact in a trunk vertebra barring the first four, the rib bearing process does not proceed along the side of the basidorsal towards the dorsal side. In the meantime another chondrification takes place at the free end of the basal stump. This is a rod-like structure representing the ventral fork of the rib (Fig. 3). At the anterior portion of the vertebra where there is the anterior connective tissue arch, connective tissue cells are aggregated at the lateral side of the centrum in the same level with the basal stump (Fig. 1). The same thing happens towards the posterior region of the vertebra. These two connective tissue aggregations on the two lateral sides of the basal stump are responsible for the formation of the horizontal wing like thin osseous processes which Wilder[10] has drawn attention to in his description of the adult skeleton. The connective tissue aggregations in question become osseous without passing through the stage of chondrification as thin membrane bones. At the posterior portion of the vertebra where there forms the posterior connective tissue arch, another condensation of connective tissue takes place at the dorsolateral sides of the arch, at a higher level than the upper end of the rib-bearer (Fig. 3). From these condensations a thin band of connective tissue cells is projected ventrolateralwards in each case. This condensation of connective tissue cells at the dorsolateral sides of the posterior connective tissue arch in each vertebra becomes osseous

as membrane bone without passing through the stage of chondrification forming the diapophysis of the posterior membrane bone arch (Fig. 6). The projected ventrolateral bands of connective tissue articulates with the rod-like rib a little below the tip forming the dorsal fork of it (Fig. 6). So that the dorsal fork of the rib of the trunk vertebra other than the second to fourth is a membrane bone. One point that we shall like to point out that the connective tissue that articulates the membrane-bone-diapophysis with the cartilaginous rod of the rib, the whole of it is never converted into bone but only that portion of it becomes membrane bone which forms the dorsal fork of the rib. Between the dorsal membrane bone fork of the rib and the membrane bone diapophysis the connective tissue band becomes a ligament. At a later stage all the cartilaginous structures of the rib and its associates become osseous. Subsequently the space between the membrane bone diapophysis on the dorsal side and the osseous basal stump at the ventral side which was filled up by loose connective tissue also becomes a thin sheet of vertical membrane bone (Fig. 10),

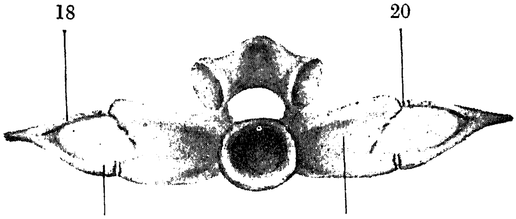


**Fig. 10.**

Posterior view of an adult posterior trunk vertebra of *Necturus maculatus*. × 2·7

which Wilder[10] in his description has referred to and which Gamble[9] has shown as merged in with the rib-bearing process. In the vertebræ from second to fourth the cartilaginous rib-bearer starts a little higher in level and it is formed along the side of the basidorsal (Fig. 11). In the meantime the cartilaginous basal stump goes upwards to meet the lower tip of the rib-bearing process. The vertebral artery lies within the curvature of the basal stump (Fig. 12). The rib-bearer sends side processes, one from the dorsal portion, a little downwards from the dorsal extremity and the other from the point of union of the rib-bearer and the basal stump. Really speaking the ventral projection is the prolongation of the basal stump. The rib has two forked processes which are articulated with the two dorsolateral projections just mentioned (Fig. 13). The ventral fork of the rib is the capitulum and the dorsal fork is the tuberculum. These two forks meet together to form the base of the rib. We like to point out here that Gamble[9] is wrong in saying that the rib is an independent structure and has nothing to do with the basal stump or parapophysis. As a matter of fact the basal stump articulates first with the rib-bearer and from the point of union the basal stump is prolonged as a lateral outgrowth. The posterior membrane bone arch has also the membrane bone diapophysis which can be found as a projection on

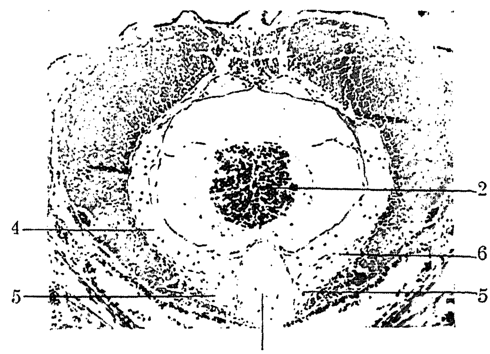


**Fig. 11.**

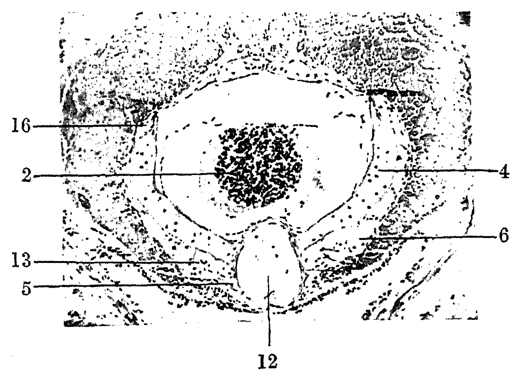


**Fig. 12.**

the top of the cartilaginous diapophysis. So in these vertebræ when ossification takes place the two forks of the bifid rib become stout rods of bone articulating with the two rods, one with the dorsal diapophysis and the other with the ventral parapophysis (Fig. 14). For the sake of comparison we have given the side view of the second, third and fourth vertebræ (Fig. 14) and have

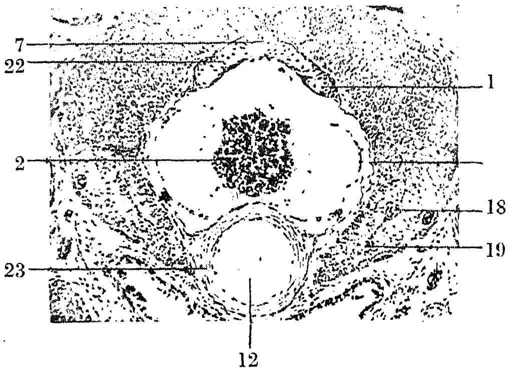


**Fig. 13.**

**Figs. 11-13.** Photomicrographs of serial tranverse sections through different regions of the anterior trunk (second) vertebra of *Necturus maculatus* at 38 mm. before the degeneration of basidorsal. × 31·5.

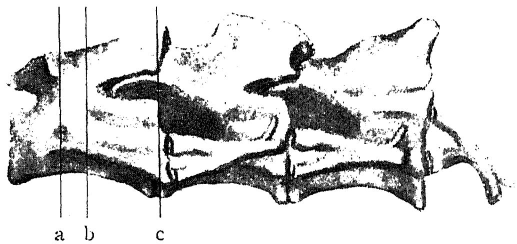


**Fig. 14.**

Side-view of the second, third and fourth trunk vertebræ of *Necturus maculatus.* × 2·4.
*a*, *b*, *c* are the planes through which Figs. 11 to 13 have passed.

marked those planes through which the transverse sections (Figs. 11–13) would have passed.

From the figures (Figs. 8–9) given by Göppert[8] and Gamble[9] one is inclined to think that both of them studied the anterior trunk vertebræ and tried to correlate with the adult posterior trunk vertebræ, otherwise they would not have mentioned that the rib-bearing process goes along the dorso-lateral side of the basidorsal. The statement of Göppert[8] is certainly better of the two workers when he has stated that there is an osseous element outside the rib-bearing process but Gamble[9] instead of advancing the idea has merged the membrane bone diapophysis along with the cartilage bone of the rib-bearing process.


[1] Gadow, H., *Phil. Trans. Roy. Soc. Lond.*, **187 B**, 1896.

[2] Gadow, H., *The Evolution of the Vertebral Column*, Cambridge, 1933.

[3] Schauinsland, H., *Handbuch der vergl. u. experim. Entwicklungslehre der Wirbeltiere*, von Oskar Hertwig, **3**, 1906.

[4] Emelianoff, S. V., *Rev. Zool. Russe.*, Moscow, 5, 1, 2 (in Russian) (Summary in German), 1925.

[5] Mookerjee, H. K., *Phil. Trans. Roy. Soc. Lond.*, **218 B**, 1930.

[6] Mookerjee, H. K., and Chatterjee, B. K., *Curr. Sci.*, **2**, No. 11, 1934.

[7] Mookerjee, H. K., and Mukherjee, A. K., *Curr. Sci.*, No. 3, 1934.

[8] Göppert, E., *Die Morphologie der Amphibien rippen.* Festschrift für Gegenbaur, **1**, 1896.

[9] Gamble, D. L., *J. Morph.*, **36**, 1922.

[10] Wilder, H. H., *Mem. Boston Soc. Nat. Hist.*, **9**, 1903.


*Numbering.*

1. Prezygapophysis.
2. Spinal cord.
3. Anterior connective tissue arch.
4. Basidorsal.
5. Basal stump.
6. Rib-bearing process.
7. Supradorsal.
8. Thickening of the connective tissue cells for the formation of the membrane bone diapophysis.
9. Connective tissue band for the formation of the ligament.
10. Posterior connective tissue arch.
11. Rib.
12. Notochord.
13. Vertebral artery.
14. Membrane bone process for the formation of the horizontal wing of the centrum.
15. Degeneration of the cartilaginous cells and the inner perichondrial layer of the basidorsal.
16. Membrane bone diapophysis.
17. Connective tissue for the formation of the vertical membrane bone of the rib-bearing process.
18. Tuberculum.
19. Capitulum.
20. Ligament.
21. Vertical membrane bone of the rib-bearing process.
22. Post-zygapophysis.
23. Intervertebral connective tissue cells that have migrated inside to form the intervertebral ligament.

## Report of the Minister of Agriculture for the Dominion of Canada for the year ended March 1933.

THE Canadian Ministry of Agriculture deals with a wide variety of agricultural activities covering every kind of agricultural interest which for comprehensiveness is not equalled by any other country. The record relates to the work of the Central Farm with its fourteen divisions, the work on the thirty Branch Farms and Stations and the departments of Dairy and Cold Storage, Health of Animals, Livestock, Seeds, Entomology, Fruits, Agricultural Economics and Publications. What a wide field is covered will perhaps be appreciated best when we point out that the Ministry controls even betting on race courses, a subject which one would hardly think of bringing within the ambit of agriculture. Details about the subject such as number of race meetings and racing days, amounts of money wagered, prize money, etc., are given with the same care and thoroughness as those relating, for instance, to manurial experiments, nutrition studies, releases of parasitic insects and the hundred other matters which one usually associates with a department of agriculture. This only shows in what an intimate manner the State concerns itself with the welfare of its foremost industry, investigating, directing, controlling and advising at almost every point. We may draw attention to another aspect of its work which marks it out as conspicuously different from what obtains in India, *viz.*, the extent of agricultural legislation and the administration of the numerous Acts passed thereunder. These deal with a variety of matters such as pest and weed control, guarantees of purity in seeds, fertilisers and feeds, disease control of livestock including bees, export and import control in respect of grades and standards of quality, packing, warehouse equipment, creamery, canning-house and elevator requirements and so on, a wide range of legislative control all calculated to advance the permanent interests of agriculture and the community though perhaps irksome and harassing to the individual. The Indian farmer is in the enjoyment of a blissful freedom in this respect—a freedom as blissful as that which permits smoking near a haystack. When one thinks of the prevalence of crop pests, contagious diseases of cattle and the confusion in the marketing methods in this country, one would welcome a powerful and liberal measure of reining in of this unholy freedom. The strict control methods have enabled the Dominion to benefit substantially by arrangements like the Ottawa Pact which, we are told, has materially increased the export trade in the United Kingdom.

We may now refer to some of the important items among the strictly agricultural activities of the department. One which is of timely interest in Mysore is the success which has attended what is called the biological method of insect control. The *Lecanium* scale is said to have been practically exterminated by this method, while against other important pests like the Oriental fruit moth, the satin moth, the green house white fly, the wheat stem saw fly and the corn borer, suitable parasites have been liberated with satisfactory results. We hope similar success will attend our own attempts in Mysore against the sugarcane borers. The increasingly large distribution of bacterial cultures of legumes is noteworthy in as much as it indicates that the true place of this method has at last been recognised, after the boom it once enjoyed and the disappointment it caused when the unduly high expectations were not realised. In the Division of Chemistry, experiments on pasture manuring and management confirm the now accepted conclusion that the stock carrying capacity is increased if the herbage is grazed quite young. The work relating to "quality" in produce such as protein and oil content in soyabeans, nicotine content of tobacco as related to "harshness" in smoking, is interesting and is worth being copied in India in regard to the chief products here. Manurial experiments bulk largely as usual in this Division; the results indicate the need for complete fertilisers including a suitable proportion of potash, an ingredient to which Indian soils have not always responded, at least as regards the *quantity* of produce. The Publicity and Extension Division maintains its high level as a model for propaganda methods. One of the happy features of this work is the intelligent response of the farmers themselves as evidenced by the co-operative experiments and the readiness with which questionnaires are answered. The various marketing and other surveys and studies of

the results of work are rendered easy and efficient by this attitude of the farming community and the report bears ample evidence of the advantages that have accrued thereby. The record of the year's work justifies the high reputation which the Canadian Department of Agriculture enjoys for the efficiency and diversity of its services.

A. K. Y.

## The Indian Lac Industry.

TO an economically impoverished country like India, the preservation and expansion of its indigenous industries should be a matter of deep concern to the Government and to the large number of people who make their living in the industry. The Indian Lac Industry supports a large population of village tribes who cultivate lac, petty contractors who collect the raw material and a number of skilled labourers connected with the conversion of stick lac from forests into the shellac of commerce.

The entire bulk of this produce is exported away to Europe and America where the commodity enters into the manufacture of a variety of products. The continued prosperity of the Indian Lac Industry therefore is closely linked up with an expansion of its consuming industries and an extension of its uses based on industrial research.

The Government of India in pursuance of its policy of supporting indigenous industries levied a cess on the export of lac the proceeds of which have since been utilised for propaganda, marketing and research. The founding of a Lac Research Institute at Ranchi, the appointment of a Special Lac Enquiry Officer in London and more recently the deputation of three Indian Research Workers to England are the three landmarks in the scheme of stabilising the industry.

We have now before us a volume on "Lac and the Indian Lac Research Institute" by the three principal officers of the Lac Research Institute at Ranchi, during the last ten years of its existence. We have also been favoured with a copy of the technical paper on "Isolation of Pure Lac Resin", the first fruits of the Indian research workers under the auspices of the London Shellac Research Bureau.

The annual report of the Special Officer is an interesting document. In the first place, the work since its inception upto 31st March 1934 has cost the Indian Government Rs. 25,000: What is the return? one is entitled to ask.

The British manufacturers are evincing some interest in lac and the Special Lac Enquiry Officer has established and maintained fruitful connections with experts in Germany and America. He is also engaged in disseminating technical information regarding the uses of lac. He has also been doing great service to the Indian Lac Industry by organising exhibitions, writing articles on lac in important Journals and Year Books, pleading for a more extensive use of lac. Under the general advice and auspices of an Advisory Committee, the London Shellac Bureau is carrying out certain pieces of investigation relating to lac; so far, except for the fact that a few promising lines of inquiry have been initiated, nothing very striking or useful has yet come out of these endeavours.

What is most needed for the Indian Lac Industry is speeding up of research which means that all our resources, money, talent and laboratory facilities not only in Great Britain but also in India should be harnessed.

We should have a parallel Advisory Board in India who will arrange for certain pieces of work relating to lac to be conducted in Universities and Research Institutes who will gladly take up such problems. A move in this direction will speed up the progress of research on lac.

M. S.

# Research Notes.

## Metrical Problems of Continued-Fraction-Theory.

KHINTCHINE (*Comp. Math.*, **1**, 361-382) has analysed the general nature of the continued fraction development of an irrational number in a very interesting way,—*i.e.*, those properties which hold good for almost all numbers. Suppose $\alpha$ represents any number between 0 and 1; and let

$$\alpha = \frac{1}{a_1} + \frac{1}{a_2} + \frac{1}{a_3} + \cdots + \frac{1}{a_n} + \cdots$$

or

$$= [a_1, a_2, \cdots, a_n, \cdots]$$

say in any abridged form. Let $m_n(x)$ be the measure of the aggregate of values $\alpha$ for which $Z_n(\alpha) = [a_{n+1}, a_{n+2}, \ldots\ldots] < x \leqslant 1$; then it has been shewn by Gauss that $\underset{n\to\infty}{\mathrm{Lt}}\, m_n(x) = \frac{\mathrm{Log}\,(1+x)}{\mathrm{Log}\,2}$. This bit of Gauss's work was forgotten until Kuzmin [*Atti. del. Congr Intern. Bologna*, 1928, **6**, 83] gave a proof of the result and also extended it. Some more important results had been obtained by Bernstein and Borel; the chief result being—If $\phi(n)$ is an increasing function then the result $a_n = 0\,[\phi(n)]$ is true or false according as $\Sigma \frac{1}{\phi(n)}$ is convergent or divergent. (It is to be noted that a set of values whose measure is zero is always excluded.) Some more results were obtained by Khintchine himself during 1923–25. These results have now been extended and beautifully precised. After proving some lemmas he obtained a general result which is of great interest. The first lemma is this:—Let $\mathrm{E}\binom{n_1, n_2, \cdots, n_k}{r_1, r_2, \cdots, r_k}$ be the measure of the aggregate of values $\alpha$ for which

$a_{n_t} = r_t\,[t = 1, 2, 3\ldots, \mathrm{K}]$. If the $n_t$'s are all different then we have

$$\frac{\mathrm{E}\binom{n_1, n_2, \cdots n_{k+1}}{r_1, r_2, \cdots\cdots\cdots r}}{\mathrm{E}\binom{n_1, n_2, \cdots, n_k}{r_1, r_2, \cdots, r_k}} < \frac{\mathrm{C}}{r^2},$$

where C is an absolute constant. Now Gauss has shewn that

$$m_n(x) = \sum_{v=1}^{\infty}\left[m_{n-1}\left(\frac{1}{v}\right) - m_{n-1}\left(\frac{1}{v+x}\right)\right] \text{ and}$$

$$m'_n(x) = \sum_{v=1}^{\infty} \frac{m'_{n-1}\left(\frac{1}{v+x}\right)}{(v+x)^2}$$

By constructing similar functional equations and using a lemma of Kuzmin he generalises his earlier result into

$$\left| \frac{\mathrm{E}\binom{n_1, n_2, \cdots, n_{k+1}}{r_1, r_2, \cdots\cdots\cdots r}}{\mathrm{E}\binom{n_1, n_2, \cdots, n_k}{r_1\, r_2 \cdots\cdots\cdots r_k}} - \frac{\mathrm{Log}\left[1 + \frac{1}{r(r+2)}\right]}{\mathrm{Log}\,2} \right| < Be^{-\beta\sqrt{n_{k+1}-n_k}}$$

where $n_1 < n_2 < \ldots. < n_k < n_{k+1}$, and B and $\beta$ being arbitrary constants. Utilising these results he proves the following important result:—Let $f(r)$ be a positive function of $r$ such that $f(r) < kr^{1-\delta}$ where $k$ and $\delta$ are two absolute positive constants. Then

$$\lim_{n\to\infty} \frac{1}{n} \sum_{k=1}^{n} f(a_k) = \sum_{r=1}^{\infty} f(r) \frac{\mathrm{Log}\left[1 + \frac{1}{r(r+2)}\right]}{\mathrm{Log}\,2}$$

for almost all values of $\alpha$. If we take $f(r) = \mathrm{Log}\,r$ then we get the interesting result that

$$\underset{n\to\infty}{\mathrm{Lt}} (a_1, a_2 \cdots, a_n)^{\frac{1}{n}} = \prod_{r=1}^{\infty} \left(1 + \frac{1}{r(r+2)}\right)^{\frac{\mathrm{Log}\,r}{\mathrm{Log}\,2}} = 2.6\ldots \text{ for almost all values of } \alpha.$$

It is of course obvious that we cannot obtain in a similar way a corresponding result for the arithmetic mean. The difficulty of this problem was already pointed out by Borel and Bernstein. By means of these methods alone the following result has been obtained:—

For every $\epsilon > 0$,

$$\mathrm{E}\left\{ \left| \frac{\mathrm{S}_n \log 2}{n \log n} - 1 \right| > \epsilon \right\} \to 0 \text{ as } n \to \infty$$

where $\mathrm{S}_n = \sum_{k=1}^{n} a_k$. This is not really equal to the result that $\frac{\mathrm{S}_n}{n \log n} \to \frac{1}{\log 2}$ for almost all $\alpha$. In fact it is known that $\overline{\mathrm{Lim}}\, \frac{\mathrm{S}_n}{n \log n}$ is infinite. Another interesting result is that $\sum_{n=1}^{\infty} \mathrm{S}_n^{-1}$ is divergent for almost all values of $\alpha$.

K. V. I.

## A Problem concerning Orthogonal Polynomials.

SZEGO (*Trans. Am. Math. Soc.*, **37**, 1, pp. 196-2?6) has proved certain interesting results in connection with the existence of two Jordan curves possessing a common system of orthogonal polynomials. Particular cases of such curves are (1) concentric circles for which $1, z, z^2, \ldots z^n, \ldots$ are the corresponding orthogonal polynomials with weight-function unity, and (2) confocal ellipses with foci at $\pm 1$ for which the Tchebechef polynomials have the orthogonal property with weight-function $|1-z^2|^{-\frac{1}{2}}$. Although he has not solved the general problem he has obtained the following two results which forms a very decisive step in the solution of the general problem. The first theorem runs as follows:

Given two analytic Jordan curves $C_1$ and $C_2$ and two continuous positive functions $n_1(z)$ and $n_2(z)$ as the respective weight-functions and if they possess the same system of orthogonal polynomials then one curve say $C_1$ must contain the other $C_2$ and $C_1$ is a level curve obtained through the conformal transformation of the outer region $(C_2)$ into the exterior of a circle, the point at $\infty$ being a fixed point; and there exists an analytic function $D(z)$ regular and $\neq 0$ outside $C_2$ ($z=\infty$ is to be considered as an inside point) such that—

$$|D(z)|^2 = n_1(z) \text{ for points on } C_1, \text{ and}$$
$$\lim_{Z \to Z_0} |D(z)|^2 = n_2(z_0) \text{ for } Z_0 \text{ on } C_2.$$

It is also easily seen that the method of proof applies for more general curves also. He has also determined all Jordan curves C and all analytic functions $D(z)$ regular and $\neq 0$ outside C which possess the property that if $C_r$ be a level curve (the transformation being the same as in the previous theorem) then the set of orthogonal polynomials with weight-function $|D(z)|^2$ are independent of $r$. He has proved that there are only five essentially different cases (ignoring multiplication by means of a certain constant and linear transformation). He has also given short and elegant proofs of the orthogonality property in these particular cases.

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## Ratio of the Magnetic Moments of the Proton and the Deuton.

THE magnetic moments of the proton and the deuton have been determined by the molecular ray method by Stern and by Rabi, but there is some discrepancy between their results. The ratio of the magnetic moments of the two particles is not therefore known with certainty. Now L. Farkas and A. Farkas (*Nature*, 1935, **135**, 372) have calculated the ratio of the magnetic moments of the two particles in question by comparing the rates of the reactions

$$\text{ortho–}H_2 + O_2 \rightleftharpoons \text{para–}H_2 + O_2 \quad (1)$$
$$\text{and ortho–}D_2 + O_2 \rightleftharpoons \text{para–}D_2 + O_2 \quad (2)$$

The calculation is made according to the formula of Kalckar and Teller: $\left(\frac{\mu_H}{\mu_D}\right)^2 = \frac{a\, k_{H_2}^{(2T)}}{k_{D_2}^{(T)}}$

where $a$ is a constant $= 1{\cdot}12$ for $T > 120°$ K. and $=1{\cdot}18$ at $T=83°$ K and $k_{H_2}^{(2T)}$ and $k_{D_2}^{(T)}$ are the velocity constants for the reaction (1) at 2T and for (2) at T. The values obtained are $\mu_H/\mu_D = 3{\cdot}85$, $4{\cdot}03$ and $4{\cdot}07$ respectively at 83°, 193° and 293° K. The variation is within the experimental error which is less than 5%.

T. S. S.

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## The Electronic Charge.

THERE is still an unsolved difficulty regarding the correct value of the charge on the electron. The oil-drop method of Millikan and its results have been discussed by Birge and yield the value $4{\cdot}768 \times 10^{-10} \pm 0{\cdot}005 \times 10^{-10}$ e.s.u. for the electronic charge. The value obtained by using the accepted structure and constants of calcite and the wavelengths of X-rays determined by means of a grating is much higher. Bäcklin has recently repeated his measurements with greater accuracy and arrives at a value $4{\cdot}805 \times 10^{-10}$ e.s.u. by this method. Now Schopper has determined $e$ by finding the total charge carried by a counted number of $\alpha$-particles and finds that $e = 4{\cdot}768 \times 10^{-10}$ e.s.u. in very good conformity with the oil-drop value. Birge and McMillan (*Phys. Rev.*, 1935, **47**, 320) have rediscussed the results of Schopper and come to the conclusion that $e = 4{\cdot}780 \times 10^{-10}$ e.s.u. This is $0{\cdot}25$% above the oil-drop value but is far lower than the value obtained from the grating measurements. A. E. Ruark (*Phys. Rev.*, 1935, **47**, 316) discusses the discrepancy between the crystal and ruled-grating wavelengths and shows that if Bäcklin's value $e = 4{\cdot}805 \times 10^{-10}$ e.s.u. (which is in very good agreement with Bearden's value

$4{\cdot}806 \times 10^{-10} \pm 0{\cdot}003 \times 10^{-10}$) is used together with the value of $\frac{e}{m} = (1{\cdot}7579 \pm 0{\cdot}0003) \times 10^7$ (e.m.u./g) obtained by Shane and Spedding, the discrepancy between the measured energy of photoelectrons and that calculated from X-ray wavelengths vanishes. This higher value of $e$ leads to $1/\alpha = 137{\cdot}04$ while Eddington's theory requires it to be 137. It thus seems as if the higher value for $e$ is more satisfactory, but then the lower values obtained by the direct methods of Millikan and Schopper remain unexplained.

T. S. S.

### Inter-molecular Compounds and Raman Spectra.

IT is well known that alcohol, ether, ketone and aldehyde molecules form addition complexes with inorganic acids and metallic halides, but regarding the nature of the complexes, whether they are valency compounds (quadrivalent oxygen, oxonium form), coordinative compounds (trivalent oxygen, onium form) or merely molecules held together by Van der Waal's, dipole, and such forces, only indefinite qualitative notions exist. Generalisations and analogy considerations are dangerous in this field of chemistry, and extensive physical investigations are greatly needed. G. Briegleb and W. Lauppe (*Zeit. physikal Ch.* (B), 1935, **23**, 154) show that as Raman spectra furnish an insight into the symmetry and binding state of molecules, a comparison of the spectra of a molecular compound with those of the components should give information about the changes in the symmetry and the binding state of the components caused by the molecular compound formation. Investigations carried out hitherto however show that no marked changes in the spectra are to be found when complexes are formed between like or unlike molecules solely on account of weak secondary valency forces. In the present paper a study of two definite molecular compounds HBr-ethyl ether, and $SnCl_4$-ethyl ether is reported. At room temperatures, a solution of HBr in ether gave the characteristic frequencies of ethyl bromide and thus showed that here the component molecules have actually reacted with each other. At $-40°$ however, a new spectrum different to that of the component molecules was obtained, corresponding to the existence of a definite inter-molecular compound. In the second case investigated, the frequencies of $SnCl_4$ were found to be considerably influenced possibly on account of a distortion caused by the neighbouring ether molecule. Further details and other studies are to be reported later.

M. A. G.

### Radioactivity of Potassium and Rubidium.

THE emission of $\beta$-rays by Potassium and Rubidium has been known for some time, but the problem of deciding the exact nature of the disintegration process has been offering various theoretical and experimental difficulties. The long life period of Potassium and Rubidium and the high velocity of the $\beta$-rays emitted by them are not to be expected from theoretical considerations. Klemperer (*Proc. Roy. Soc.*, 1935, **148**, 638) has critically examined the different schemes suggested by Gamow for the disintegration process. (1) Simultaneous emission of 2 $\beta$-rays for each decaying atom. (2) An $\alpha$-ray change followed by a fast $\beta$-ray change. (3) The Ca and Sr formed as a result of slow $\beta$-ray change from K and Rb respectively, may decay rapidly giving fast $\beta$-rays. Klemperer has finally arrived at the conclusion that the radio activity is not due to $K_{39}$ and $K_{41}$ but to $K_{40}$, and in the case of Rubidium to $Rb_{86}$. The process suggested is as follows:—

$$K^{40}_{19} \rightarrow \beta + Ca^{40}_{20}$$
$$Rb^{86}_{37} \rightarrow \beta + Sr^{86}_{38}$$

Of the two groups of $\beta$-rays emitted, one of them may be connected with $\gamma$-ray emission. It has been shown that $K^{40}_{19}$ has a resultant nuclear spin of 4 or 5 while $Ca^{40}_{20}$ has zero spin. Since according to the Fermi theory the life-time of a $\beta$ emitting radio element depends upon the initial and final spin of the nucleus, the contradiction between half life period and $\beta$-ray activity of Potassium and Rubidium is cleared up.

M. P. V.

### Distillation with Mercury Vapour.

DISTILLATION with steam is a well-known and important method used widely in the separation and purification of organic compounds. For substances of boiling point 400° or over, however, this method cannot be employed. H. Decker (*Ber.*, 1934, **67**, 1636) has now carried out some successful experiments using mercury in the place of steam. He finds that many high boiling compounds go over with mercury nearly

a hundred degrees below their boiling point, the volume of mercury coming over, in the cases investigated being but 1/10 of the distillate. The distillation can be carried out in a perfectly smooth manner. Indigo, chrysen and pyren are among those tried. It should be possible to distil out the high boiling compounds from such substances as resins and pitch, and the various other possibilities of this method have yet to be worked out.

M. A. G.

### Action of Water on the Latent Photographic Image.

FORMATION of a flat image, if considerable time elapses between the exposure and development of photographic emulsion kept in a warm humid climate is a common experience. Howard James and co-workers (*J. Phys. Chem.*, 1934, **38**, 1211) have made systematic investigations on the rôle played by water in the above effect. If Azo emulsion is exposed to light so as to produce a considerable developable density, the latent image is either reduced or completely destroyed by the action of water vapour for several hours. Bromide emulsion requires longer treatment with water vapour. The dried emulsion gives a satisfactory print on second exposure. Formic acid, acetic acid vapours and liquid ethylene glycol are even more effective than water vapour. Ether, ethonol (absolute), carbon tetrachloride, carbon disulphide, benzene and nitro-benzene are however without any appreciable effect, in the vapour phase. The softening action common to the first group of substances on gelatin, probably facilitates the reversal of the exposed grain.

According to photographic theory, exposure of the emulsion to light results in the liberation of equivalent quantities of silver and halogen and the latter taken up by "the halogen acceptor". Gelatin in gelatin emulsion usually plays the rôle of the halogen acceptor. A more powerful halogen acceptor, like silver nitrate in the gelatin emulsion, will prevent the action of water vapour on the reversal. Complete destruction of the image is not possible unless the light exposure is small, and the amount of residual density increases with the period of exposure. On strong exposure some of the halogen is probably removed from the sphere of action and consequently the image cannot be completely destroyed. Water vapour has also sensitising action on the emulsion. The unexposed emulsion on treatment with water vapour and drying acquires increased sensitivity. Water vapour treatment over several days produces fog which resembles very closely that due to age (age mottle).

K. S. R.

### The Cotton Wilt Disease in Bombay.

A full and connected account of the ten year research work on the Wilt Disease of Cotton carried out as one of the research schemes financed by the Indian Central Committee by Mr. G. S. Kulkarni and his assistants on the Dharwar Experiment Station appears in the *Indian Journal of Agricultural Science*, Vol. 4, Part VI. The studies have related to practically every relevant factor but from the point of view of controlling the disease they have yielded no useful results. In the last resort the breeding of resistant types appears to be the most promising line of work. Resistant types evolved by selection alone proved low yielders and therefore commercially of little value. The need for combining resistance with high yield by cross-breeding and also of a study of the different physiological strains of the fungus itself together with the reaction of the types of plants evolved to each of these strains is indicated. The observation that soil temperatures between 20° C. and 27° C. constitute the optimum for the development of the disease is made use of in a technique for testing types for wilt resistance rapidly. Provincial research to evolve types suited to the different important cotton tracts appears to be the only means of solving the difficulty.

### The Farm Cart with Pneumatic Dunlop Tyres.

RESULTS of comparative tests regarding the performance of farm carts fitted with pneumatic tyres as against the ordinary steel tyred carts are summarised in the *Journal of Agriculture and Live-stock in India*, Vol. 5, Part I. The summary relates to trials conducted in Lyallpur in the Punjab and at the Agricultural College Farm, Poona. The draft with the rubber-tyred cart is greatly reduced, the reduction varying from 26 to 39 per cent. depending upon the load carried and the kind of road traversed. With a draft ranging between 200 lbs. and 250 lbs. the country cart pulls a load of one

ton while the rubber-tyred cart pulls about two tons. Tests relating to durability are still wanting and the relative costs for the new equipment over a reasonably long working period have still to be worked out.

### Production of Canesugar in India in 1933-34.

THE SUGAR Technologist to the Government of India gives an account of the progress of sugar making in India during 1933-34 in the *Journal of Agriculture and Live-stock in India*, Vol. 5, Part I. The number of factories that worked during the year was 112 as against 57 during the previous year, a truly astonishing advance due certainly to the protection which the sugar industry now receives. About 15% of the factories worked between 150 and 174 days, 20% worked between 125 and 149 days, about 21% worked between 100 and 125 days and 25% worked between 75 and 100 days. Only one factory worked up to 200 days and one likewise over 200 days. The working season of the remainder was under 75 days. The maximum daily crushing for any factory was 1,604 tons of cane, while the lowest was only 15 tons. The outturn of sugar per cent. cane crushed taking all-India figures advanced only slightly over those of previous years, being only 8·80, which compared with the 11 to 12% outturns of Java should be deemed to be low. The damage due to frost, floods and insect pests, and the disastrous earthquake which occurred in Bihar, were responsible for the low outturn and the shortened crushing season of many factories. The Technologist strongly stresses the importance of well-qualified technical experts in the factories to ensure efficient working. The total production of sugar for the year was 453,965 tons as against 290,177 tons in 1932-33.

### The Utilisation of Cane Molasses as Cattle Feed.

LABH SINGH records some further observations on these trials in the *Journal of Agriculture and Live stock in India*, Vol. 5, Part I. These further trials disclose the rather important result that cattle fed on molasses in the summer months are injuriously affected. It is recommended that molasses feeding be confined to the winter months and up to a quantity of 2 lbs. per animal.

### The Pollination of the Apple.

VERY interesting observations of much practical importance made as the result of a four years' study are recorded in *Bulletin* No. 162—New Series, of the Canadian Department of Agriculture. All varieties of apples produce better crops when cross-pollinated with another suitable variety with the exception of "Baldwin" which is self-fruitful. There is much difference in respect of the suitability of varieties as cross-pollinators, and a list of those suitable and unsuitable among the ordinary commercial varieties is given. Among the former are Alexander, Cox's orange, Jonathan, Rome Beauty, while among the latter figure Blenheim, Gravenstein and Ribston. A second point brought out is that insect pollinators are required by all varieties, wind pollination alone giving unsatisfactory results. The need for the provision of colonies of bees in apple orchards is emphasised.

### *Entamœba Kamala* n. sp.

UNDER the title "Etiology of Enzootic Bovine Haematuria" Captain S. C. A. Datta, B.Sc., M.R.C.V.S., has contributed a very valuable article to the *Indian Journal of Veterinary Science and Animal Husbandry*, Volume IV, Part IV. Although Bovine Haematuria has been known to occur in countries as widely separated as Australia, Great Britain, and parts of Europe and America and India, yet very little is definitely known as to its nature and cause. In this article which is profusely illustrated with plates definite evidence has been furnished to prove that it is a parasitic disease due to a large protozoan organism which seems to belong to *Phylum Rhizopoda*. It is similar to but larger than *Entamœba histolytica* and affects bovines. The author proposes therefore the name *Entamœba Kamala* for this new species of parasite. As this knowledge is bound to be of great value in the control of the scourge, Captain Datta deserves the gratitude of the Veterinary Profession and the stock-owning public. His further notes on the subject will be keenly awaited.

S. D. A.

### Effect of X-Rays on Chromosomes.

C. L. HUSKINS AND A. W. S. HUNTER (*P.R.S.* B, 1935, **117**, No. 802) have described a few examples of breaks and translocations of

either whole chromosomes or of their constituent chromatids caused by X-irradiation in the nuclei of the microspores of Trillium. Lateral translocations of fragments on to a broken chromatid were found with a high frequency in the first mitotic prophase after irradiation. The six anthers of a bud in this species are usually at the same stage of mitotic cycle and thus it was possible to determine with accuracy the exact stage of division at the time of irradiation, by immediately fixing one of the anthers. Apparent constrictions of chromosomes were found upon destaining to be merely chromatid breaks. Cases of *de novo* origin of trabents and an example of ring-formation have been recorded. The "delayed action" of X-rays, so commonly observed by several authors to become apparent first in the anaphase of the first division following irradiation, is explained on the basis that chromatid breaks will not be obvious before anaphases in chromosomes which are not stained to show the internal structure and that they may, owing to the surrounding matrix which holds them together, not be seen until the next division. The arguments of Darlington, and Mather and Stone on the time of chromosome splitting are critically analysed and the conclusion is reached that the somatic chromosomes of Trillium microsporocytes, including the "attachment constriction" are longitudinally double at all stages except just prior to anaphase separation when they are 4-partite.

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## Somatic Synapsis in *Chironomus*.

R. L. KING AND H. W. BEAMS have described (*Journal of Morphology*, 1934, **56**, 527) the somatic chromosomes of *Chironomus*. The diploid number is 8. In the spireme nuclei of Salivary glands they find four segments, each representing a pair of homologous chromosomes in intimate somatic synapsis. Each pair could be recognised by its characteristic distribution of chromatin discs. The somatic synapsis in *Chironomus* is not a simple approximation of homologous chromosomes, but can be compared to meiotic synapsis.

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## Development of *Cheyletus eruditus*.

OUR knowledge of the developmental history of Acarina is very meagre and the interesting article by H. A. Hafiz [*Proc. Roy. Soc. Lond.* (B), 803, 1935] is certainly welcome. Earlier investigators like Kramer, Claparéde, Michael, Neustead and Duval have restricted themselves to the description of a few stages. The cellular development in a parthenogenetic individual like Cheyletus clears some very abstruse points in the organogeny of the mites. He has studied from the blastoderm formation (which takes place from 1–4 hours) up to the final stage, *i.e.*, the emergence of the hexapod larva (92–96 hrs.). A single layer of blastodermal cells is formed; this differentiates itself into a median and two lateral plates. The ventral plate elaborates endoderm cells; the middle plate gives rise to mesoderm cells. Five pairs of thickenings form the larval appendages. The absence of anus is characteristic of not only the adult but also the embryonic stages. "Salivary gland" cells arise in association with the trachæ.

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## Diorite–Limestone Reaction, a Study in Contamination.

IN the current issue of the *Geological Magazine* (March 1935, No. 849) Miss Joplin of Cambridge has contributed a very instructive article on the reaction between diorite and limestone and consequent contamination. The area studied is situated in New South Wales and is made up of shales, quartzites and limestones. The limestones have been invaded by a series of tongues of diorite, and these have been contaminated by the assimilation of lime and has given rise to definite and sharply marked off mineral assemblages. This reaction has produced well-marked zones which can be differentiated into diorite core, zone of turbid felspar, clinozoisite zone and garnet zone. By a detailed study of the chemical analyses of these different rocks, she has been able to deduce certain physical conditions controlling contamination. By comparing these deductions with the well-known works of Eskola, Read and Tilley she concludes that the degree of concentration of the foreign material is the most important factor in contamination and that assimilation takes place at a low temperature in the presence of abundant volatiles of which water is the most important.

# The National Institute of Sciences of India.

By L. L. Fermor, O.B.E., D.Sc., F.G.S., F.R.S.

THE extent to which modern civilised man has become dependent in all directions for his welfare and happiness upon the results of scientific researches and their applications has for some decades caused all civilised countries to make provision for such research. This research is financed by one or more of four agents, namely, (1) the State, (2) educational organisations and institutions, (3) commercial and industrial concerns, and (4) private benefactors; and the total amount of such provision and the proportion of its derivation from these four sources depend partly upon the general wealth of a country, partly upon the extent and variety of its natural resources, and partly upon the general degree of education and enlightenment of its inhabitants, the last factor being usually the most important.

In India, although the larger proportion of the population has been illiterate through the ages, there has always been a nucleus of men of learning, and in very early days some attention appears to have been given to scientific studies, particularly mathematical and astronomical and also in natural history. The full extent and value of the knowledge so acquired is not yet known, and probably never will be known, as its discovery depends upon the interpretation and elucidation of ancient manuscripts, many of which are either lost or very fragmentary.

The course of the study of modern science in India has been discussed briefly in two recent addresses. In my Presidential Address to the Asiatic Society of Bengal in February I have given a sketch of the development of scientific research in India to the end of the 19th century, whilst in my Inaugural Address to the National Institute of Sciences of India in January, I gave an account of the development of scientific research in India in the 20th century. The two addresses, although to some extent overlapping, really form a continuous story, and the reader may be referred to them in their respective publications.*

Your Editor has asked me to write an article on the National Institute of Sciences of India. In accepting this invitation it has seemed to me that it would be useful if I showed the position of this organisation with reference to other scientific organisations in India, as it is only in this way that one can see clearly what place the National Institute should occupy in the edifice of Science in India, and, therefore, what its functions should be.

Briefly, the position is that provision for modern scientific work in India commences in the days of the East India Company with the recruitment of Medical Officers and Mint Assayers, who, towards the end of the 18th century, with interested civil and military officers, began in their spare time the first modern scientific investigations. At this time the general need for an organised association for the encouragement of the study of all branches of learning became felt, and on the 15th of January 1784, at a meeting presided over by Sir William Jones, the Asiatick Society was founded, later to be termed the Asiatic Society of Bengal. The objects of this Society were both scientific and literary, and in the comprehensive words of Sir William Jones as paraphrased "The bounds of its investigations will be the geographical limits of Asia, and within these limits its enquiries will be extended to whatever is performed by man or produced by nature".

The first organised provision for scientific research in India was, therefore, actually non-official; but in 1788, the Royal Botanic Gardens, Sibpur, were founded; and in 1800 the first of the scientific services, namely the Trigonometrical Survey of the Peninsula, later to become the Great Trigonometrical Survey and now merged in the Survey of India, was established by the East India Company with Colonel Lambton as the first geodesist. The Geological Survey of India was founded in 1851, and in 1866 the first Museum Act was passed and the Indian Museum was established, the zoological, geological and archæological collections of the Asiatic Society being transferred thereto; and with the foundation of this Museum we have the first direct official provision for zoology. Provision for meteorology in the form of various observatories existed in various parts of India from the end of the 18th century and in the early 19th century, and in 1875 the Government of India appointed a Meteorological Reporter for the

* *Journal and Proceedings of the Asiatic Society of Bengal* and the *Proceedings of the National Institute of Sciences* respectively.

whole of India, and the present Meteorological Department was founded.

The 19th century was thus a period during which the various scientific services financed by the Central Government were founded. All these services eventually inaugurated their own publications, but throughout this period the Asiatic Society of Bengal was the place where men of all branches of knowledge met and discussed their problems, and the publications of this Society contain not only literary communications but also many papers of importance to Science. During the 19th century, branches of the Royal Asiatic Society of Great Britain and Ireland were established in Bombay and Madras, and that very successful Society, the Bombay Natural History Society, was also founded. There were also other less important societies, often evanescent; but on the whole it was a century characterised by the existence of scientific services and of one academy serving the whole of India, namely the Asiatic Society of Bengal. None of the specialist scientific societies had been founded, and the major portion of the researches that were not published in departmental publications found their way to the Asiatic Society of Bengal.

With the 20th century we have opened another volume in the scientific life of India, and the first third of the century has been characterised by the formation of a large number of specialist societies and research institutes. Amongst the societies mention may be made of the Mining and Geological Institute of India (1906), the Indian Mathematical Society (1907), the Institution of Engineers, India (1921), the Indian Botanical Society (1921), the Indian Chemical Society (1924), the Institution of Chemists, India (1927), the Society of Biological Chemists (1931), and finally of the Indian Physical Society, the Indian Society of Soil Science and the Indian Physiological Society, all founded last year.

Amongst the research institutes supported from central revenues one may mention the Imperial Institute of Veterinary Research now at Muktesar but originally founded at Poona under another name (1890); the Imperial Agricultural Research Institute, Pusa (1903); the Central Research Institute, Kasauli (1906); the Imperial Forest Research Institute, Dehra Dun (1906); and the All-India Institute of Public Health and Hygiene, Calcutta (1934). As examples of research institutions administered provincially mention may be made of the School of Tropical Medicine, Calcutta, and the Haffkine Institute, Bombay. And as a fine example of another type of research institute, namely one supported mainly by private bequests supplemented by Government grants, we have the Indian Institute of Science, Bangalore (1911).

All these societies and institutes, except the Indian Institute of Science, must be regarded as specialised organisations.

But starting in 1857, with the foundation of the Universities of Bombay, Calcutta, and Madras, there has been formed a series of university educational institutions with chairs and laboratories for various science subjects, playing an important part in the provision of facilities for scientific research. The scientific societies all maintain their own publications, but happily the tendency is for our University friends to offer the results of their researches to existing scientific societies rather than for Universities to start their own journals and so increase the multitude of publications.

The tendency of the 20th century in India has been, therefore, towards intense specialisation in science with resultant segregation of scientists into specialised bodies. Fortunately, however, this tendency was recognised quite early in the century and the Indian Science Congress was founded (1914) deliberately to lead men of all branches of science back to a common meeting ground. This body, however, meets but once a year and does not, therefore, provide for the periodic meetings of men of all sciences throughout the year.

As already explained the Asiatic Society of Bengal provided such a forum throughout the 19th century. This was during the period when by far the larger part of the scientific research done in India was based on Calcutta or found its way there due to the presence of the Central Government. But there are now numerous other research centres in India and consequently, as India is a large country equivalent in size to the continent of Europe without Russia, it follows in practice that men of all centres of research cannot make personal use of the Asiatic Society of Bengal, which, though an All-India Society and, in fact, if one attends to its original objectives an All-Asia Society, can, for geographical reasons, in many respects serve practically only a limited portion of India.

It was this practical difficulty that really led to the foundation of the United

inces Academy of Sciences in 1930, and to a demand for an Indian Academy ciences, the later demand overlooking act (1) that in the Asiatic Society of al there was already—though not under name—an Indian Academy of Sciences Letters theoretically available to re- nt and cater for the whole of India, (2) that in practice no one society of emy rank could cater effectually for the e of India.

e disagreement amongst scientists in during 1934 over this Academy prob- though it arose otherwise, was funda- ally due to these facts; and in the end ical recognition has been given to the that scientists in India need for their nuous service at least three Academies ience, and as a result we now have the Academies located respectively in tta (Asiatic Society of Bengal), Allaha- United Provinces Academy of Sciences), Bangalore (Indian Academy of Sciences).

I have pointed out in the Addresses red to above, Academies must really be ded as philosophers' gardens, where of various branches of knowledge can and talk, compare their views, and ss their problems; and it is in providing ce where men of various branches of ledge can meet and talk that Academies o be distinguished sharply from spe- t societies.

ilst it has become clear that no one emy can serve the practical needs (apart those served through the post) of the of India, it is also clear that we require ordinating body to facilitate co-opera- in the first instance between the various emies, but ultimately between all scienti- ganisations and scientists, and it is this rlying need that has really led ultimately e formation of the National Institute iences of India.

is unnecessary to explain at length bjects of this Institute. It is sufficient produce Rule 2 of the Provisional Rules e National Institute:—

OBJECTS.

The objects of the National Institute iences of India are:—

The promotion of natural knowledge in India ling its practical application to problems of al welfare.

To effect co-ordination between scientific mies, societies, institutions and Government ific departments and services.

To act as a body of scientists of eminence for omotion and safeguarding of the interests of scientists in India; and to represent internationally the scientific work of India.

(*d*) To act through properly constituted National Committees in which other learned academies and societies will be associated, as the National Research Council of India, for undertaking such scientific work of national and international importance as the Council may be called upon to perform by the public and by Government.

(*e*) To publish such proceedings, journals, memoirs and transactions and other publications as may be found desirable.

(*f*) To promote and maintain a liaison between Sciences and Letters.

(*g*) To secure and manage funds and endowments for the promotion of Science.

(*h*) To do and perform all other acts, matters and things that may assist in, conduce to, or be necessary for the fulfilment of the above-mentioned aims and objects of the Institute.

It seems unnecessary to discuss in detail the various objects of the Institute, as each of them speaks for itself. But from the statement it will be seen that the main objects of the National Institute are related to the co-ordination and organisation of science in India, and this is the reason why the Institute has a limited Fellowship composed of Fellows belonging to all branches of science.

In the first year or two of its life the Institute will naturally proceed cautiously, but gradually, as opportunity occurs and funds permit, scientists in India must expect the National Institute to take up all the objects enumerated above, and as this is done we shall call upon the Academies and the specialist societies for their co-operation.

Although this is not the main object yet it is inevitable that when the Fellows meet they should take the opportunity to bring researches of general interest before the whole body of Fellows, and to this extent the National Institute must serve as a forum where important discoveries are announced and discussed.

In Rule 2 (*e*) reference is made to possible publications of the National Institute. The publication of *Transactions* and *Proceedings* has been commenced, but the most important publications are expected to be an annual review of science and a publication containing collected summaries of papers read before Academies and scientific societies in India.

As is now known to all scientists in India, the foundation of this National Institute represents an act of co-operation between the senior scientists of all parts of India. The Council has been chosen so as to give a

wide geographical distribution of Members of Council, including provision for an additional Vice-President and an additional Member of Council representing each of the three existing Academies and the Indian Science Congress, and all these bodies have shown their co-operative spirit by duly appointing their representatives to the Council. The Fellowship of the Institute includes representatives of all sciences; of the scientific services, of the universities, of the research institutions, and of scientists employed by commercial and industrial organisations; and the National Institute represents the co-operative effort of men of all races, religions and branches of science in India. It is hoped that the country will be proud of this comprehensive organisation and that all scientists will regard it as an honour to be elected a Fellow thereof.

There is an urgent need in India for co-operation between men of different communities, and I take this opportunity to express the hope that we shall succeed in providing in this National Institute a bond between scientists throughout India and an organisation that will act by its existence and its success as an example and an encouragement to men of other walks of life, by showing what is possible in the way of co-operation between men of diverse and yet ultimately similar interests.

## Science Notes.

*X-Ray and Photographic Reversal.*—Messrs. K. Prosad and B. N. Ghosh, Science College, Patna, write under date 23rd February 1935, "When materials are exposed to a beam of X-ray for the purpose of obtaining their diffraction halos, it is a familiar fact that the impression of the direct beam on a photographic plate on development, comes out sometimes dark and sometimes white. This phenomenon does not appear to have attracted sufficient attention, much less investigated in any detail.

While engaged in confirming with the help of X-rays, the results of structural analysis of some solids as obtained by the method of Latent Splitting (*Nature*, 1931, **127**, 90; *Bulletin, P. S. C. Phil. Soc.*, 1933, No. 3; 1934, No. 4; 1935, No. 5), the attention of one of us was drawn to the apparently irregular manner in which the central spot on the negative came out dark or white depending on the length of exposure. The appearance of the impressions suggested that the phenomena might be due to photographic reversals by X-rays. To test this suggestion, a systematic investigation has been undertaken using a Hadding tube. Exposures on Golden Iso Zenith plates of speed 1100, with 10 milliamperes fixed discharge at 50 KV, using a copper anticathode, have been given for times varying from 1 sec. to 5 hrs. The result has been a series of negatives of a highly interesting character in which opacity and transparency alternate with each other varying in intensity with time.

The first reversal, that is, transparency superposed on the opacity of the image appears for about 10 mts. exposure. The transparency then gradually increases until an exposure of about 2 hrs. is reached when an opacity is again superposed on the former transparency. This second opacity increases upto an exposure of about 3 hrs. At this point a second transparency sets in which slightly increases upto an exposure of about 3½ hrs. A third opacity then starts which increases upto an exposure of nearly 4¼ hrs. A third transparency is then again noticeable superposed on the last opacity and increases in magnitude upto an exposure of about 4¾ hrs. At this point a fourth opacity sets in which goes on increasing upto the maximum time of exposure of 5 hrs. given in these experiments. The differences between successive maxima of opacity and transparency gradually diminish and will probably disappear with still longer times of exposure.

Although the phenomena of one or two photographic reversals (R. W. Wood, *Phil. Mag.*, 1903, 6, 577), with stimuli of different kinds used in certain order or those due to overexposure using ordinary light are well known, it is however not certain that several reversals with one kind of stimulus, specially with the X-rays, have been previously obtained. A very interesting account of the existing knowledge on the subject is given in Chapter XV of Allen's book on Photo-Electricity. Fuller details of the work will appear elsewhere."

* * *

*Fossil Wood from the Bababudan Hills, Mysore.*—Charles S. Pichamuthu writes that while examining the iron ore deposits of the Bababudan Hills during the Dasara vacation in the year 1932, the writer came upon a specimen of fossil wood near Kemmangundi. It was found near the 6th furlong of the 27th mile on the Chikmagalur to Lingadhalli road. The road here has been cut along the sides of the hill, and it was from this cutting that the specimen was obtained. The hill, which is 4,500 feet above sea level, is composed of red earth containing lumps of iron ore.

The woody material has been completely converted into hematite. As the fossil was of a rather friable nature, it was with great difficulty that it could be sliced. The specimens and sections were kindly examined by Professor John Walton, Professor of Botany in the University of Glasgow. He was of opinion that it was fossil wood, but considering the imperfect preservation of the structures, he did not like to say more than that it was of gymnospermous character. Recently, specimens were sent to Dr. Sahni who agreed with Professor Walton's identification.

The iron ores (as opposed to the banded ferruginous quartzites) of the Bababudans, have been, in part, segregated by the action of water through the ages. Some of the ores have

undoubtedly accumulated in standing bodies of water, solutions having leached the iron from the ferruginous quartzites. This specimen of wood must have been washed into one of these sedimentation areas and had its woody material replaced by oxide of iron.

It may be mentioned that there are, at present, no gymnosperms on these hill ranges.

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*The Porphyry Dykes of Mysore—A Study in Contamination.* B. N. Raghunatha Rao, writes that in describing the "Closepet Granites" of Mysore the Officers of the Mysore Geological Department have frequently noticed cases of local contamination of the acid magma by basic material. A very good example of such a contamination on a wider scale is afforded by the porphyry dykes of Mysore (Mandya and Seringapatam Taluks), which I have been recently studying. These dyke rocks appear to have consolidated from a highly contaminated magma due to the relatively more acid residual phases of the "Closepet Granite" magma having more or less assimilated portions of the basic country rocks such as the hornblende schists, chlorite schists and the pyroxene granulites thus giving rise to the dykes of a monzonitic character. Among the chief evidences in support of such a view may be mentioned: (1) the constant presence of basic xenoliths in these dyke rocks, in all stages of assimilation and recrystallisation, (2) the abundant development of sphene, apatite and magnetite in the proximity of these basic xenoliths, (3) the frequent occurrence of minerals such as melanite and spinel, and (4) the heterogeneity in the general character of the dykes occurring in a group—as for instance near Bethalli and Arakere.

Further work is in progress and a fuller paper dealing with the subject will be published elsewhere.

* * *

*The Blue Colour of the Sky.* Dr. M. Zakiuddin writes: "In a previous communication (*Current Science*, 1934, 3, 83) I have mentioned about the interesting manuscript of Al-kandi dealing with the blue colour of the sky, a copy of which is preserved at Oxford (No. 877, *Katalog der Bodleiena von J. Uri.*, Bd. 1) and a copy of which has been recently discovered by H. Ritter (*Archiv. Orientalni Prage*, pp. 363-372, 1932). The manuscript has been also edited at Aligarh after a careful comparison as it has been found that the copy preserved at Oxford is full of mistakes.

It is interesting to note that Prof. E. Wiedemann (*Arbeiten aus den Gebieten der Physik, Mathematik, Chemie—Julius Elster und Hans Geitel*, pp. 118-126, 1915, called "Anschauungen von Muslimischen Gelehrten uber die blaue Farbes des Himmels"), of Edlangen has translated the Oxford copy. Wiedemann, however, mentions a very interesting manuscript dealing with the problem of the blue colour of the sky by the Egyptian jurist Qarafi (Eder *Jahrbuch der Photographie and Reproduktintechnik*, 1913 and 1915).

Schihab al Din Ahmed Ibu Idrio al Qarafie lived in Cairo and has written a book on 50 different problems of optics. He died about 1283-84. Of all those problems, the problems No. 33, 34, 35 deal with the cause of the blue colour of the sky (*loc. cit.*).

Later on Wiedemann mentions of another manuscript of Qazwini (*vgl. Z. B.*, Qazwini Bd. 1, Text S. 170 von Ethe 347) that also deals with the same problem.

* * *

The Association of Special Libraries and Information Bureau (ASLIB) is to hold its twelfth annual conference at St. John's College, Cambridge, during the week-end beginning Friday, September 20. Particulars may be obtained from the Secretary of the Association, 16 Russell Square, London, W. C. 1. Sir Richard Gregory has agreed to accept re-nomination as president of the Association for 1935-36.—(*Nature*, March 1935.)

* * *

*Seasonal Progress of Height Growth in Trees.*—By H. G. Champion. (*Forest Bulletin*, No. 88, Silvicultural Series, 1934. Government of India Publication.)

"Data for the seasonal progress of height growth collected between 1922 and 1933 on 15 common Indian trees are examined and average curves derived. The marked variation in the increment curves in successive years is discussed in relation to the curves for temperature, rainfall and soil moisture, close agreements being few. The specific increment curves are classified into three types: (i) simple curve with single maximum (*Adina* and *Tectona*), (ii) curve relatively simple but with secondary maxima (*Terminalia*), (iii) curve complex with two or more primary maxima (*Shorea, Pinus* and *Eugenia*)."

* * *

*The Distribution of Temperature in the Upper Levels of a Depression Originating in the Bay of Bengal during the Indian South-West Monsoon.* By N. K. Sur (Indian Meteorological Department, *Scientific Notes*, Vol. VI, No. 62).

"During the period of activity of the south-west monsoon some depressions originate in the Bay of Bengal preceded by a well-marked fall of pressure in Burma. These generally move in a north-westerly direction through the central parts of India and reach the neighbourhood of Rajputana. Sounding balloon ascents at Agra, when one such depression was passing through Rajputana, show that the upper levels of air in its outer regions were characterised by temperature lower than the normal values for the corresponding heights in the monsoon season. The level of tropopause above the depression was also found to be lowered."

* * *

*Goat Breeding Scheme for South India.*—The Imperial Council of Agricultural Research, New Delhi, at their meeting on February 28, 1935, sanctioned a ten-year scheme for Goat breeding under the auspices and direction of the Arcot Mission Agricultural Institute, Katpadi. The anticipated and sanctioned expenditure is Rs. 84,172 including Rs. 5,480 as non-recurring and Rs. 78,692 as recurring expenditures.

OBJECTS OF THE EXPERIMENT.

The Madras Presidency is reported to have eleven million goats of a non-descript variety. Among them exist great differences as to colour, size, milking capacity and other characteristics associated with a definite breed. The purpose of this research project is to make a concentrated attempt to select certain types and strains and with a definite ideal in mind work toward the consolidation of desirable characteristics into a definite breed indigenous to South India. The

plan is to have 200 females in the milking herd of which half the number will be used to breed South Indian varieties pure; one-fourth blood from the Jumna-Pari from North India will be used and Surti blood from Western India on the remaining fourth. Comparative figures will be kept of such factors as milk production, hardiness, prolificacy, milking longevity, intervals between kiddings, suitability of various feeds and fodders and observations of diseases and their treatment.

Propaganda work will also be carried on educating the public especially the poorer village classes who cannot afford the risk of maintaining the better grade of cattle, in the advantages of the "Poor man's cow" especially for milk production to improve the rather poorly balanced villagers' diet. Animals from these improved varieties will be put at stud in the district to improve the local goats.

EXPENDITURES.

The Imperial Council has agreed to make the following sums available for the experiment :—

| | Rs. |
|---|---|
| 1. Purchase of stock, office and dairy equipment .. .. .. | 5,480 |
| 2. Staff—Assistant, writer, maistry and coolies .. .. .. | 26,928 |
| 3. Feeding expenses for the goat herd .. | 45,564 |
| 4. Recurring, office, dairy and sundry expenses .. .. .. | 6,200 |
| TOTAL EXPENDITURE .. | 84,172 |

The American Arcot Mission agree to give the services of Mr. J. J. De Valois, the Principal of the Agricultural Institute, to supervise the work as well as to provide the necessary buildings of a very simple but suitable nature for the project.

The scheme was drawn up with the co-operation of the Madras Agricultural Department officers who were interested in the work the Mission was doing with goats on a very small scale. The Director of Agriculture, Madras, was largely responsible for securing the final approval of the Imperial Council authorities.

* * *

We have great pleasure in congratulating Dr. T. Vijayaraghavan, (at present) Reader in Mathematics in the Dacca University, on his election as Visiting Lecturer for 1936 by the American Mathematical Society. He is the first Oriental Scholar to receive the distinction, which is conferred on very able non-American mathematicians achieved hitherto only by a few European workers of the front rank. Vijayaraghavan's ability was first noticed during his undergraduate years by Prof. K. Ananda Rao of the Presidency College, Madras; his original papers were forwarded to Prof. G. H. Hardy in England who unhesitatingly placed him second, even at that early age to the late S. Ramanujam. He was awarded a special scholarship of over a thousand pounds by the Madras University for research in England under the guidance of Prof. Hardy, then at Oxford. He published three papers on Tauberian Theorems which have become an integral part of the standard literature on the subject. These and some other minor papers won for him the Doctorate Degree.

Subsequently he published his paper dealing with the famous Borel conjecture in the *Comptes rendus* of the Paris Academy in 1932.

Émile Borel, one of the outstanding mathematicians, made a highly plausible conjecture in 1899 on the orders of infinity of solutions of differential equations. It was immediately accepted by all, including Hardy, as true; but years passed by without a single proof in spite of all the efforts of the best mathematicians all over the world. The problem came to be ranked as one of great difficulty, being slightly less than those of the Riemann hypothesis, Fermat's last theorem and Goldbach's theorem. As such it was suggested by Hardy to the mathematical workers in his seminar lectures. After six years of quiet work, Vijayaraghavan proved Borel's conjecture as also that of others to be wrong, the conjecture, natural as it appears, being actually false! The little note referred to above ranks as one of the greatest achievements of recent mathematical thought, not only by its conclusions but in the elegance of method, finish of technique and incisive of analysis.

We wish all success to a scholar who is still young. We have no doubt that he will bear with honour a large share of the burden left upon mathematicians in India by the premature death of Ramanujam.

* * *

*The Institute of Chemistry of Great Britain and Ireland (Indian Section).*—The Annual General Meeting of the Indian Section of the Institute of Chemistry of Great Britain and Ireland was held at the University, Calcutta, on January 5th, 1935, Dr. H. B. Dunnicliff, D.Sc., F.I.C., in the Chair.

The Report and financial statement presented by the Honorary Secretary was read and approved.

The following members were elected to the Committee for the year 1935.—

Mr. G. C. Mitter, M.Sc., A.I.C., Bombay; Dr. R. H. Peacock, D.Sc., F.I.C., Burma; Dr. E. Spenser, D.Sc., F.I.C., Bengal; Dr. B. B. Dey, D.Sc., F.I.C., Madras; Dr. J. N. Ray, D.Sc., F.I.C., Punjab; Dr. S. Krishna, D.Sc., F.I.C., United Provinces; Mr. G. W. Douglas, B.Sc., A.I.C., Honorary General Secretary.

A number of matters relating to the proposed Sectional Rules and to the formation of subsections in India were discussed, the meeting terminating with a vote of thanks to the Chairman and Honorary Secretary.

* * *

*International Society of Leather Trades Chemists (Indian Section).*—The Annual Meeting of the Indian Section of the International Society of Leather Trades Chemists was held at the Bengal Tanning Institute, Calcutta, on January 6th, 1935, with Mr. B. M. Das, President, in the Chair. The Annual Report of the Honorary Secretary was read and approved. A number of matters relating to the Sections activities were discussed and the hope expressed that all those who were interested in the Tanning Industry in India would avail themselves of the facilities provided by the Society. The following are the Committee for 1935.—

*President.*—Mr. B. M. Das, M.A., M.Sc.; *Committee.*—Messrs. B. B. Dhavle, M.A., A.I.C.; N. N. Dutt; R. F. Roll; C. O. Tattersall, B.Sc., A.I.C.; G. W. Douglas, B.Sc., A.I.C. (*Honorary Secretary*).

The meeting terminated with a vote of thanks to the Chairman and Honorary Secretary.

On the conclusion of the meeting the members present were shown over the Bengal Tanning Institute by the Superintendent, Mr. B. M. Das.

* * *

*Association of Economic Biologists, Coimbatore.*—At a meeting of the Association of Economic Biologists, Coimbatore, held on the 7th March 1935, Dr. F. J. F. Shaw, D.Sc., A.R.C.S., F.L.S., Director, Imperial Institute of Agricultural Research, Pusa, delivered an able address on "Chance and Error". On the 22nd March 1935, Dr. P. J. Gregory, M.A., Ph.D., F.R.M.S., F.L.S., delivered an illuminating lecture illustrated with lantern slides, on "the chromosome structure".

* * *

*New Fellows of the Royal Society of Edinburgh.*—According to an announcement in *Nature*, Dr. B. N. Desai, Assistant Meteorologist, Government of India, Dr. B. Narayanaswamy, Lecturer in Physiology, University of Patna and Mr. C. S. Pitchamuthu, Assistant Professor of Geology, University of Mysore, have been elected ordinary Fellows of the Royal Society of Edinburgh at a meeting held on 4th March 1935.

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We understand that Col. C. A. Gill, K.H.S., I.M.S., Inspector-General of Civil Hospitals, Burma, and late Director of Public Health, Punjab, has been appointed to undertake an investigation into the Malaria Epidemic in Ceylon.

* * *

Dr. Ernest Muir, of the School of Tropical Medicine, Calcutta, will soon be leaving India after 29 years of work connected with leprosy relief and kala-azar, to become Medical Secretary of the British Leprosy Relief Association.

Dr. Muir first came to India in 1906 as a medical missionary to the U.F.C. Church Mission at Kalna, where he worked for 14 years. During the later part of his stay at Kalna he became greatly interested in the subject of Leprosy. He was responsible for starting the Leprosy Research Department at the Calcutta School of Tropical Medicine, in November 1920. Three fundamental problems in which he was interested in connection with Leprosy are (1) culturing of the organism responsible for leprosy on artificial media, (2) finding a suitable experimental animal susceptible to infection, and (3) the improvement in the treatment of leprosy, the present method being tedious and requiring prolonged treatment, Dr. Muir worked on these problems for 15 years, as a result of which India is now covered with a net-work of leprosy clinics. A heap of publications stand to his credit and in association with Dr. Napier he published a handbook on Kala-azar and with Sir Leonard Rogers a handbook on Leprosy.

* * *

According to a note appearing in *Chemical Age* the Government of India reports that two separate agreements have been negotiated with Imperial Chemical Industries, Ltd., in connection with the Company's proposal to erect an alkali factory. One with the Punjab Government dealt with the supply of limestone, and the other with the Government of India referred to the supplies of waste salt, brine and other products in the Khewra salt mines. The agreement with the Government of India provided for a five-year option to the company to take up a fifty-year concession for the exclusive right to obtain the salty material in question, for use in a factory, subject to the safeguarding interests of the Government of India and of those concerns already established and which were engaged in the production of refined table salt. (*Chemical Age*, 1935, 32, 230.)

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The Chemical Engineering Congress of the World Power Conference will be held under the auspices of the International Executive Council from June 23-27, 1936, at the Central Hall, Westminster, London. Information regarding the Conference can be obtained from the Congress Office, 56, Victoria Street, London, S.W.1.

* * *

*Report of the Third Imperial Mycological Conference.*—The Imperial Mycological Conference, held once in five years, affords an excellent opportunity for discussing Plant Pathological problems in the British Empire. The third conference was held in London during September 1934, and was attended by Plant Pathologists designated from all over the Empire. India was represented by Dr. W. McRae and Dr. Chaudhuri. It is interesting to note that representatives of firms, manufacturing fungicides also attended the conference.

After the opening address by Sir Charles Howell-Thomas, K.C.B., K.C.M.G., Dr. E. J. Butler, C.M.G., C.I.E., F.R.S., the Director, reviewed the work of the Institute. He gave staggering figures of annual crop losses due to fungal diseases in Great Britain, the Irish Free State, Australia, Holland and Switzerland. Cereal losses alone were estimated at £100 millions annually. He deplored the apathy of Government towards organising this branch of Agricultural Science and emphasised the need of co-operation between the Plant Pathologist and the Plant Breeder. It is interesting to learn that scale insects in the Seychelles, were effectively controlled by fungal cultures, obtained from Mysore, of *Cephalosporium lecanii*, which parasitises green bug on coffee.

The discussion on administrative measures (including Legislation) against plant diseases resulted in the adoption of a resolution recommending a uniform health certificate throughout the Empire. The possibility of introduction of plant diseases by air transport was also discussed, and it was recommended that there should be a general prohibition of transport by air of living plants. Methods of standardization of insecticides and fungicides were discussed, with the representatives of manufacturing firms.

The report of the discussion on virus diseases of plants and Foot rot of cereals contains valuable facts. The need for simplification of control measures suited to the small cultivator was emphasised, and formed the subject-matter for discussion. The important subject of breeding and selection for immunity against plant diseases was also discussed, and papers were read on various tropical diseases. The delegates visited the Imperial Mycological Institute, and the East Malling Research Station.

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*Report of the Veterinary Director-General for the year ending March 31st, 1933 (George Hilton, V.S.H., A.R.C.V.S.), Department of Agriculture, Canada.*—One of the most important activities of the Department was the prevention of importation of Epizootics especially, Foot and Mouth disease from Europe and the United States. Progressive measures for the control of Bovine

Tuberculosis have been adopted with the co-operation of the live-stock owners and public health bodies, with very satisfactory results. Attempts to similarly deal with bovine contagious abortion also which is gaining in prevalence are started. A Virus disease of foxes kept in captivity was studied which evidently resembles the distemper of dogs. A similar disease in sledge-dogs was investigated with the help of the Royal Canadian mounted police. Researches into Bovine Hæmaturia and Equine infectious anæmia (Swamp Fever) are undertaken besides other diseases.

At the Imperial Economic Conference, agreement was reached on several points, chief among which are reduction of the quarantine period for animals imported into Canada and curtailment of restrictions on Canadian cattle exported to Great Britain.

The most important feature of the report is, the splendidly organised campaign for the eradication of Bovine Tuberculosis. The measures adopted include, Single Herd policies, Accredited Herd plan, Supervised Herd plan and restricted area system. In some cities and towns the municipal tuberculosis order is in force under which dairy cattle are tested free with tuberculin and compensation is paid for reactors which are slaughtered. During the year, 79,805 tests were made and 987 reactors were slaughtered and compensated for under this order.—S. D. A.

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*Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the Year ending 31st March*, 1934.—This report like its predecessors makes interesting and instructive reading. Details of the Establishment, Estate, Biological Products, Technical instruction, Publications by the staff and the financial position are furnished.

The following are some of the important findings in the Research Department :—

Rinderpest :—Further tests with Goat Virus as an immunising agent against Rinderpest were conducted with encouraging results. This method of inoculation has been tried on a much larger scale in the provinces and the results are so satisfactory—mortality being negligible—that further extension of the work is predicted.

Anthrax :—Vaccination with formalinised tissues from animals dead of Anthrax were found safe for administration but the immunity conferred was not satisfactory.

Black Quarter :—Finding immunity by muscle and culture filtrates not very effective, formalinised whole culture vaccines were prepared and used for the first time this year with very satisfactory results.

Congenital Amaurosis :—Evidence has been produced to show that the blindness in calves often results from a deficiency of minerals or vitamins.

Ephemeral Fever :—A case of this disease has been studied and it has been found possible to transmit it to healthy animals by inoculating the blood taken at the height of fever although animals in close contact would not contract it. As this disease seems to be of common occurrence in other parts of India, a more exhaustive study of it is imperative.—S. D. A.

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From a report appearing in *Statesman* of the 5th April, it is understood that the Royal Institution has decided to establish a Professorship of Astronomy and that Sir James Jeans has been nominated as the first holder of the Chair.

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The Health Commissioner of the League of Nations has arranged for a second course of instruction in Malariology which will commence at the King Edward VII College of Medicine at Singapore on the 29th April 1935. The theoretical and laboratory studies will continue until 2nd June after which the candidates will proceed in groups either to Malaya, Java or French Indo-China for a further period of practical field work extending over three weeks. Facilities will be provided for experienced Malariologists to pursue individual research during the period of the course and at other times by arrangement with the King Edward VII College of Medicine.

The object of the course is to complete the training of medical practitioners who are engaged or intend to be engaged in the work of malaria control in their own countries.

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*International Committee of Annual Tables of Constants*— A.$^T$C.—We are informed through the courtesy of the General Secretary of this important organisation, M. Ch. Marie, 9, rue de Bagneux, Paris (VI), that the Academy of Sciences of U.S.S.R. has signed an agreement with the Committee of A.$^T$C.

This agreement guarantees for the coming five years an important contribution to the International Fund of the publication of A.$^T$C. In exchange the U.S.S.R. Academy of Sciences is to receive a certain number of volumes edited by the Committee of the A.$^T$C. These volumes are going to be distributed among the Universities and Scientific Institutions of the Soviet Union.

Similar agreements have been already signed with the French Government, the Helvetic Government and the Polish Academy of Sciences.

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*Hilger Catalogue F.—Spectroscopic and Other Accessories* (54 pages, 9½ × 7 ins. ; with index ; issued gratis). Adam Hilger Ltd., 98, Kings Road, Camden Road, London, N.W. 1.—Adam Hilger Ltd. issue a series of eleven principal catalogues of which the present Catalogue F. is a member. It deals with the wide range of accessories and minor apparatus that can be supplied for spectroscopic and other purposes. Some idea of the variety of these can be judged from the fact that in its 54 pages the following are listed among a large number of other items :—

Condensing lens and mounts, mirrors, absorption tubes and cells, various types of spectroscopic slits and eyepieces, levelling tables, vacuum pumps, discharge tubes, sodium and cadmium lamps, arc and spark stands, AC—DC rectifier, pure and rare metals, Judd Lewis comparator, thermopiles, photo-electric cells, photographic materials, and publications.

On page 40 a description is given of a new type of galvanometer relay which is capable of increasing the sensitivity of galvanometer systems several hundred times.

A comprehensive index is included. Prices are printed in a separate price sheet, a copy of which accompanies every catalogue.

The same firm are also issuing free of charge, a convenient stiff card folder in which their catalogues may be kept ready for reference on the bookshelf.

From an *Associated Press* message, we learn that the Tibetan Government has consented to a British Expedition to Mount Everest during 1935-36. Mr. Hugh Ruttledge has accepted the invitation extended by the Mount Everest Committee to lead the expedition.

The Government of India have sanctioned 3 Himalayan Expeditions (1) Dr. Schiebe will lead a party of German Botanists, who intend exploring the botanical potentialities of Chitral, (2) Dr. Ph. C. Visser, the Netherlands Consul-General in India and Ceylon will lead another Expedition this summer to the Shaksgam area in Eastern Karakoram, which he has visited twice before, and (3) Mr. M. Escarra will lead a French Alpine Club Expedition next summer, to explore the peaks about Baltaro Glacier, including the well-known $K_2$, the second highest peak in the World.

* * *

The first annual conference of the Bengal Pharmaceutical Association was held during the first week of April, Mr. H. Cooper, Ph.C., presiding. In the course of his address, Mr. Premananda Das, Ph.C., as Chairman of the Reception Committee, said that the Association has been planned to bring together on a common platform all manufacturers, wholesalers, importers, chemists and druggists and compounders with a view to facilitate mutual exchange of ideas, co-operation and help to eliminate misunderstanding, difficulties, drawbacks and the most unhealthy competition in price-cutting against each other. The Association intends to start a Journal of its own which will serve as a medium for discussing topics of interest to pharmacists and distributing information in the variations in prices in the World's market.

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Death occurred on 19th March 1935 at the age of 73 of Dr. Carl Duisberg, Chairman of I. G. Farben-industrie and famous German Chemist who discovered benzopurpurin and benzozurin. He was an eminent economic thinker and industrial leader and held office as President of the Reich Federation of German Industry from 1925–1931.

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We acknowledge with thanks the receipt of the following:

"Agricultural Gazette of New South Wales," Vol. XLVI, Part 2, February 1935.

"Actualités Scientifiques et Industrielles,"- Nos. 176, 190-192, 196, 199, 201, 204, 206-207, 209-218, 221-222, 226.

"The Journal of the Royal Society of Arts," Vol. LXXXIII, Nos. 4292-95.

"Biochemical Journal," Vol. 29, No. 2, February 1935.

"American Journal of Botany," Vol. 22, No. 2, February 1935.

"The Journal of the Indian Botanical Society," Vol. 13, No. 4.

"The Journal of the Institute of Brewing," Vol. XLI (Vol. XXXII, New Series), No. 3, March 1935.

"Canadian Journal of Research," Vol. 12, No. 2.

"Chemical Age," Vol. 32, Nos. 817-820.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 3.

"Experimental Station Record," Vol. 70, Index Number.

"Forschungen und Fortschritte," Vol. II, Nos. 7, 8, 9.

"Transactions of the Mining & Geological Institute of India," Vol. 29, Part 4, March 1935.

"Indian Trade Review," Vol. XIII, No. 75, March 1935.

"Monthly Statistics of the Production of certain selected Industries of India," No. 8, 1934-35.

"The Indian Forester," Vol. LXI, No. 4.

"Communications from the Kamerlingh Onnes Laboratory of the University of Leiden," Nos. 229-232; and Supplement No. 76 to Nos. 229-240.

"Forest Research in India," 1933-34, Part II, Provincial Reports.

"Bulletin of the Geological Institution of the University of Upsala," Vol. 24.

"Research and Progress," Vol. I, No. 1, January 1935.

"Half-Yearly Journal of the Mysore University," Vol. 7, No. 2.

"Memoirs of the Indian Meteorological Department,"—Vol. 6, Nos. 61-62 and Vol. 5, Nos. 46-60 Table of contents and errata.

"Nature," Vol. 135, Nos. 3408-3411.

"Natural History," March 1935.

"Acta Phytogeographica Suecica," VI, die-Verbreitung der Höheren Wasserpflanzen in Nordeuropa. By Gunnar Samuelsson.

"The Journal of Chemical Physics," Vol. 3, No. 3.

"Journal de Chimie Physique," Vol. 32, No. 2.

"Indian Journal of Physics," Vol. 9, Part III.

"Proceedings of the Indian Association for the Cultivation of Science, Vol. 18, Part III.

"The Indian Trade Journal," Vol. CXVI, Nos. 1499-1503.

"Arkiv för Zoologi," Band 27, Häftes 1 & 2.

# Academies.

## Indian Academy of Sciences.

(*Proceedings*, 1935, No. 9, March.)

SECTION A.

C. V. RAMAN: *On Iridescent Shells; Part I.—Introductory.*—W. T. Schmidt's elaborate investigation on the chemical and physical nature of the nacreous substance is summarised. C. V. RAMAN: *On Iridescent Shells, Part II.—Colours of Laminar Diffraction.*—The characteristic iridescence of shells is a diffraction effect which appears as one of the orders of spectra produced by the periodic structure at the surface of the shell. S. CHOWLA: *On Sums of Powers (II).* S. CHOWLA: *Note on Hypothesis K of Hardy and Littlewood.* J. B. SETH: *A Regularity observed in the Second Spark Spectrum of Iodine.* AKSHAYANANDA BOSE: *The Weiss Constant of Paramagnetic Ions in the S-State, Part I.—Aqueous Solutions of Manganous Salts.*—Careful measurements on aqueous solutions of $MnCl_2$, $Mn(NO_3)_2$, and $MnSO_4$ show that there is no deviation from the theoretical simple Curie law of temperature dependence. A moment of 29.3 to 29.4 Weiss magnetons is found for $Mn^{++}$ ion, in agreement with the theoretical value 29.4. G. V. JADHAV AND Y. I. RANGWALA: *Bromination of Substances containing two Aromatic Nuclei, Part II.—Bromination of Phenyl and Cresyl Esters of m- and p-Nitro Benzoic Acids.*—It is found that bromination proceeds readily without a carrier with phenyl *m*-nitro-benzoate and phenyl and *o*- and *m*- cresyl *p*- nitro-benzoates, while with other esters, the presence of nitric acid is necessary. HANSRAJ GUPTA: *On the p-Potency of G (n, r).* H. LESSHEIM AND R. SAMUEL: *On the Pair Bond Theory of Valency.*—Chemical union is regarded as mainly an effect of the degeneracy due to the electrons. This leads to an electron pair bond theory of valency. According to this view, which is supported by spectroscopic evidence, the various additional hypotheses such as the octet rule and its extensions are unnecessary.

SECTION B.

B. N. SINGH, R. B. SINGH AND K. SINGH: *Investigations into the Water Requirement of Crop Plants.*—The paper deals with the water requirements of 57 different species and varieties of crop plants grown at the Experimental Station of the Institute of Agricultural Research, Benares Hindu University. B. N. SINGH AND R. K. TANDON: *Temperature-absorption characteristics during germination in seeds of different structure and biochemic constitution under varying concentrations of oxygen and water supply.*—The results of an experimental study of water absorption in thirteen varieties of seeds at different temperatures and three distinct environmental conditions—maximum water—no free oxygen; moisture and air conditions maintained at optimum level; and atmospheric moisture with free aeration. B. R. SESHACHAR: *The Golgi bodies in the Erithrocytes of* Ichthyophis glutinosus. T. EKAMBARAM AND RAMA RAO PANJE: *Contributions to our knowledge of* Balanophora.—Investigations of a South Indian form of *Balanophora dioica* R. Br., show that the life-history of the plant is a normal angiospermous sexual cycle with reduction-division (normal type) and a strong evidence of fertilisation. COL. I. FROILANO DE MELLO: *On two spiral organisms living in the intestinal tract of* Gallinula chloropus, L.—One type, treponema, identified as an avian variety of *spirochæta eurygirata* Werner *emend* Fantriasm; the other type, spirella, differing from the genotype *S. regandi* in having two anterior flagella and classified as *spirella gallinulæ* sp.n. K. M. GUPTA: *Critical remarks on* Dipterocarpoxylon Burmense *Holden.*—Irrawadioxylon *Gen. Nov.* S. K. PANDE: *Notes on the Anatomy of a Xerophytic Fern,* Niphobolus adnascens *from the Malay Peninsula.*—This epiphytic fern shows well-marked xerophytic adaptations. K. RAMIAH, N. PARTHASARATHY AND S. RAMANUJAM: *A Tetraploid plant in Wild Rice*—Oryza Longistaminata.—For the first time a tetraploid plant of *Oryza Longistaminata* is described.

# Reviews.

THROUGH SPACE AND TIME. By Sir James Jeans. (Cambridge University Press, 1934.) Pp. vi+224. Price 8*s*. 6*d*. net.

Some one has described Sir James Jeans as a "man of science" who is also an artist. To this we may aptly add that he is a literary scientist. The lay reader eagerly welcomes any composition from the pen of Sir James Jeans, as he has the unique gift of making the story of science fascinating to the general reader.

The book under notice is the latest of Sir James' popular books on Astronomy and Astrophysics. It is based on the series of lectures delivered by him at the Royal Institution during the Christmas of 1933. The book itself is divided into eight chapters under the following headings:—The Earth, the Air, the Sky, the Moon, the Planets, the Sun, the Stars and the Nebulæ.

At the very outset the author proposes to take his readers on an imaginary journey through space and time and make them see for themselves the wonders of the universe. To begin with, in the first chapter, we are asked to delve into the bowels of the Earth. Here the author tells us the story of evolution in a simple and attractive manner. The prehistoric dinosauri and other monsters are brought before us and we learn of them

as if at first hand. The picture of the Diplodocus as a monster weighing as much as a whole family of elephants—"Father, mother, children and perhaps several uncles and aunts as well"—is amusing if not entirely truthful.

The chapter on "the Air" is mainly meteorological—treated so as to make it interesting to people who have not had the advantage of being trained in that science.

In the first two chapters Sir James Jeans is not in his element—he is not a palæontologist or a meteorologist though he has the rare faculty to make anything he handles interesting.

In the third chapter, the classical theories of cosmogony of Ptolemy, Hipparchus and others are lucidly expounded so that even children could peruse them with profit. A notable point in this connection is the way in which Sir J. Jeans explains away the difficulties raised by Tycho Brahe—who could not understand why the sky did not change in appearance from time to time if the earth were moving in space. Jeans compares the earth to a rose bud in a vast garden and man crawling like a green fly on the rose bud could not discover any re-arrangement in the remote reaches of the garden—and for the same reason we are unable to detect any change in the arrangement of the stars even though the earth is hurtling in space at the rate of about 18 miles per second. The problem of the expanding universe has been propounded in an admirable manner and the comparison of the nebulæ to drifting straw bits on an ever-widening river is particularly striking as it effectively brings home to the mind of the reader such an abstruse thesis as this.

Certain very minor slips have crept in, probably during the passage of the book through the press, as for example, on page 142 where a reference is wrongly made to an illustration of Mercury.

The book, we have no doubt, will be a very useful addition to all public and private libraries—and must certainly be read by every one who wishes to be acquainted with the recent scientific developments. The attractiveness and simplicity of style and the homely exposition of abstruse scientific theories, must create a great demand for this book. We regret that we have no such Institution in India which could arrange similar lectures. Sir James Jeans is always read with avidity wherever English language is spoken and in this little book he excels himself. We hope that many more equally entertaining and informative books will be forthcoming. This little book deals with great problems in an easy and charming manner which every great scientist and school boy can read with profit and pleasure.

C. N. R.

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L'ELECTRON POSITIF (No. 182 of Actualités Scientifiques et Industrielles). By Irène Curie and F. Joliot, Paris: Hermann et Cie. 1934. Price 10 fr.

The contributions of Mme. Irène Curie and M. F. Joliot to the subject of the present volume have been of fundamental importance. After the discovery of the positron by Anderson had received confirmation by the work of Blackett and Occhialini, Curie and Joliot showed that the positrons must be due to the conversion of $\gamma$-rays into matter. The whole story of these discoveries is well told in the brochure before us which provides an authoritative and complete account of the experimental studies dealing with the positron. The theoretical aspects are only mentioned in passing. Four plates containing beautiful photographs of the tracks of positrons enhance the value of the work. We should like to mention in passing that calling the positive electron sometimes as positron but more often as positon leads to some confusion. Similarly the abbreviation for electron-volts is given variously as eV., *ev.*, and e.V. Apart from these minor matters, and some three typographical errors on p. 3, l. 7, p. 8, l. 2 from bottom and p. 11 legend to Fig. 3, we have no hesitation in welcoming the appearance of the monograph as most opportune.

T. S. S.

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THE POETRY OF MATHEMATICS AND OTHER ESSAYS. By David Eugene Smith. Published by Scripta Mathematica, Yeshiva College, Amsterdam Avenue and 186th Street, New York, N.Y.

This is a neat little book of four popular essays by the well-known author of the History of Mathematics. The object of the author seems to be to furnish material which will interest not only teachers of mathematics but all who recall their contact with the subject in their school or college days.

The first essay deals with features common to poetry and Mathematics, such as Imagination, Rhythm and Symmetry. The second gives a really novel view of looking

at Religion in a mathematical way, namely, drawing inferences from a definite set of postulates. The author has given a lead to the theologians by a model example.

The third and the fourth articles are merely biographical notes on Thomas Jefferson, President of the United States, who took a great deal of interest in Mathematics and especially Astronomy and M. Monge, the celebrated mathematician of differential-equations fame and his association with the French Republic as Minister of Marine and later with Napoleon Bonaparte. It is curious that in France of all countries mathematicians easily find a place in the government of their land, the late M. Painlevé being the most recent and outstanding example.

The essays are extremely readable and interesting to the professional as well as the amateur mathematician, and the book will easily be a useful addition to all our school and college libraries.

B. M. N. R.

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ANALYSE DES MECANISMES CHIMIQUES CHEZ LES ETRES VIVANTS. By T. Cahn. (Hermann et Cie, Paris, 1934, Pp. 23.) 8 fr.

The composition of several biologically occurring substances is little known, the concentration in which they occur is too small in many cases, and the physico-chemical conditions in which they exist also play an important part. In spite of all these difficulties, chemical analysis of the organisms can give important information regarding the mechanism of the reactions in living bodies. After an interesting introduction to the subject, the author has given in this monograph an account of particularly the diastatic reactions occurring in the tissues, and the knowledge that can be gained about their mechanisms from a study of the concentrations and nature of the coferments occurring in them.

M. A. G.

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HYDROSTATICS AND MECHANICS. By A. E. E. McKenzie, M.A. (Cambridge University Press, 1934. Pp. 272.) Price 3*s.* 6*d.*

The book is the first of three volumes covering the sections into which Physics is usually divided and deals with that portion which is usually regarded by students as the dullest part of the subject; but the author has eminently succeeded in presenting the subject in an interesting and practical, and therefore useful, manner. In dealing with pressure in liquids, an account is given of utilisation of water power by harnessing water falls and building dams across rivers, and the practical aspect is stressed by calculations made without entering too much into technicalities—an aspect which deserves to be emphasised in high schools and intermediate colleges. Similarly, practical treatment is adopted in dealing with the principle of Archimedes, theory of machines, and the parallelogram law. The diagrams are very neat and the pictures lucid. Examples worked out are apt.

The book deserves a place in the libraries of high schools and junior colleges.

K. N. KINI.

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SIMPLE SCIENCE. By E. N. da C. Andrade and Jullian Huxley. (Basil Blackwell, Oxford. Pp. 688.) Price 8*s.* 6*d.* net.

There is a feeling among educationists that all is not well with the science syllabus in the secondary school. The remedy suggested is not so much a curtailment of the scope of the subjects as a judicious redistribution and inclusion of the biological sciences as an integral part of the course of study in science. Here, it may not be out of place to put in a word for greater attention to be paid to Biology. Though many phases of life are affected by scientific advance, and biology can claim a fair share of the credit, still it will hardly be too much to say that to most people Biology is only of secondary importance—Physics and Chemistry coming in for the largest share of their sympathy. Besides, it is thought that the interest in Biology is purely academic. However, it is refreshing to note that in the series of popular books which Professors Andrade and Huxley have written, they have in a great measure, overcome this shortcoming.

The book under notice is divided into three parts. In the first of these the authors have endeavoured to place before the young reader for whom it is intended a general outline of the Natural and Physical Sciences. In doing this the authors have developed a method that is all their own. Among several instances we may cite,—one feels particularly impressed by the way they stress,—"that all things obey laws". The law that governs Stellar motion can with equal facility be applied to the motion of every other moving system in the universe. Another admirable example of a similar

kind is the way they impress the imponderability of energy. Actually energy is not a material thing, but is an agency capable of different manifestations. To bring home this idea to the young reader the authors have by an array of ingenious examples striven their utmost. Needless to say they have succeeded completely. An abstruse concept such as Heredity is lucidly expounded and is treated in a laudable manner. Simply and clearly they have taught that like brings forth like.

In the second part—Science and Life (review *Curr. Sci.*, May 1933)—the elementary laws of Physics and Chemistry together with those of Biology are explained in a praiseworthy fashion and is a logical sequel to the first part.

In the third section—Forces of Nature—a more detailed and advanced treatment of the subject-matter of the two previous books is given. A notable feature of this book is that wherever possible the everyday aspect of scientific knowledge has been emphasised. Technical applications have been accurately described without the employment of jargon.

In conclusion, we have no hesitation in recommending this book as suitable for courses of study in the lower forms of secondary schools. We hope that the authorities will appreciate the efforts of the authors and lend them the support they so well merit. Again, we may congratulate Professors Andrade and Huxley on having produced this eminently readable work, deserving a place in all the libraries both public and private.

C. N. R.

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YOUR MEALS AND YOUR MONEY. By Gove Hambidge, Whittlesey House. (McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C. 2. Pp. xvi+179. 1934.) Price 6*s*. net.

This is an interesting book full of practical suggestions for securing a complete diet based on different levels of income. It seems to us that the book will be found useful not only to parents but to the statesmen who are both concerned in the health and efficiency of the people. To the general Medical practitioner, it is almost indispensable.

The author bases his book on the U. S. Department of Agriculture circular called "Diets at Four Levels of Nutritive Content and Cost", by Hazel K. Stiebling and Medora M. Ward. It is almost superfluous to point out that a sound and detailed knowledge of food should have a direct bearing on agricultural policies. The cardinal principle of all such policies must be to encourage the production of the right kinds and the right quantities of foods, and it is obvious that the general public must have authoritative facts about diet in relation to their well-being, the standards of good nutrition and the factors in the selection of the right type of diet for the promotion of health and efficiency of people. In India the great majority of people have practically no knowledge of the nutritional requirements and standards and the nutritional values of common foods and especially in tropical countries where the climate is so inhospitable, every wage earner should have an adequate information about what to eat, how much to eat and how much to spend on himself and his family for food.

The book will, we expect, be received in India with enthusiasm. It gives in a simple and complete manner an account of the researches and conclusions of scientists, which result in fixing standards of nutrition for different classes of people; the practical bearing of these standards on their meals; the welfare of the nation which depends on how its members eat and the adjustment of agriculture from which the supply is obtained. A perusal of this extremely interesting book will convince the readers that the diet of the people affects their welfare and productive efficiency which in their turn determine the character of their agriculture. The chief problem with the Indian population is what foods they should buy out of a given amount of money each week so as to secure the greatest possible nutritive value out of them. India wants definite dietary patterns for the use of her poor and rich families such as Stiebling has prepared for the use of American families and which are presented in the book with illuminating commentaries.

The book is divided into seven chapters, and the first one deals with the proximate principles and general problems. The second chapter which deals with "costs" deals with the family budget in relation to standards for safeguarding the health of its members. Four different plans are given over expenditure, and every one of these is calculated to ensure the necessary elements in correct proportion suited to age, occupation and finance. Naturally these plans or patterns discuss groups of foods and their contribution to the diet and the third chapter

is devoted to a detailed examination of each class of food-stuff in order to bring out the significance of balanced diets. The next two chapters discuss quantities and nourishment which are clear statements of scientific facts of great importance. Chapters six and seven which deal with thrift and national well-being are the most important sections of the book, and we can hardly think of any one who can afford to be independent of a complete knowledge of both. In the supplement is given retail prices of food materials used in computing costs for the four plans.

The chief merit of the book is its simple and clear exposition of the scientific researches and conclusions of a large body of American scientists and economists, and the wealth of information contained within its compass is as rich as it is varied. Indeed this is a family dietary book and every householder who can read and write the English language must possess a copy of it.

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"ANALAR" STANDARDS FOR LABORATORY CHEMICALS. Formulated and issued jointly by the British Drug Houses, Ltd., and Hopkin and Williams Ltd., London. 1934.

There are perhaps very few publications in which the chemist will find such an indispensable wealth of material as the one before us; during the conduct of his scientific work, it is supremely important that he should be aware of the purity of the materials he handles and for this purpose, it is very desirable that he should avoid the tedious testing of the materials by being able to rely upon each substance conforming to a specific standard. This need is supplied to a generous extent by the book before us which has been published as a co-operative effort by Messrs. British Drug Houses Ltd., and Messrs. Hopkin and Williams, Ltd., the two well-known firms who have for several decades now principally concerned themselves with the manufacture of fine chemicals for Laboratory use. The term "laboratory chemicals" is used comprehensively to include "chemicals for analytical, research, teaching and all other laboratory purposes." The two Firms have hitherto had their individual books of standards and by pooling together their knowledge and experience their chemical staff have brought out a highly useful and up-to-date volume and thereby earned the gratitude of the Chemical world. The book deals with some 200 substances and in each case the physical and chemical properties are listed and thus forms a valuable record of the chief properties of the chemicals with which it deals. Quantitative assays for the chemicals have been prescribed and the minimum percentages specified. The maximum limits of impurities are also listed.

The book deserves to find a place in the hands of every chemist. It may also be mentioned here that the Firms have now placed on the market all the laboratory chemicals listed in the volume, under the trade name "Analar" which carry a guarantee of "purity".

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VIRUS DISEASES OF PLANTS. By John Grainger (Oxford University Press, London. Pp. 102.) Price 6*s*. net.

The subject of virus diseases of plants is one of great interest not only to those who are interested in the fundamental aspects of the problem but also to practical agriculturists who are deeply concerned with the welfare of their crops which are affected by a number of virus diseases. Dr. Grainger's contribution to this subject in the form of a text-book provides introductory information on this important aspect of plant pathology.

The author has incorporated a good deal of his own experience in this field and the experimental technique described on some aspects of the subject provide sufficient detail for enthusiasts to conduct experiments on the field with crops which may be affected with disease. The numerous references cited at the end, constitute a useful feature of the volume.

M. S.

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BIOLOGY FOR EVERYMAN. By Sir Arthur Thomson. 2 Vols. Edited by E. J. Holmyard. (J. M. Dent & Sons, Ltd., London. Pp. 1600, 1934.) Complete Price 15*s*. net.

We have taken some time in reading these two volumes, and as we were not obsessed by any apprehensions of an Examination, we must say at once that we have derived great pleasure and instruction from their perusal. Thomson was always a skilful writer, possessed a clear and delightful style, besides a complete knowledge of all the branches of Biology. The present volumes which are full and authoritative are a great achievement, surpassing any of his previous publications in scope and treatment. Singularly enough they do not produce the nausea usually associated with Text-Books and the intention of the author as well as that of the publishers, *viz.*, that they should

be read by "everyman" without being bothered by technicalities and professional detail, is admirably fulfilled.

The two volumes are divided into four books. The first volume is taken up with Book I which is devoted to the treatment of the anatomical characteristics, taxonomy, bionomics, ecology and ancestral history of the members of the different phyla of the animal kingdom. The second volume comprises the next three books. The second book deals with the general principles and philosophy of Zoology. The plant world is considered in Book III, and in sixteen chapters, we have a clear and adequate account of the flowering and non-flowering plants. The fourth Book is exclusively occupied with the story of man. Every chapter is attractive and instructive, and the entire exposition is simple and eminently readable. Even the lay reader is able to follow the argument of the fundamental scientific principles, while the students of biology are offered a constructive and synthetic exposition of the different aspects of biological knowledge. The book may be used therefore by the general reader for appreciating the biological phenomena and by the systematic students of science for purposes of examination. To combine the interests of these two classes of readers, which are not entirely identical, is a task worthy of a great scientist, and the two volumes represent a landmark in the history of scientific books. They constitute a great and indispensable publication useful alike for study and reference.

Towards the close of the second volume the author strikes a high ethical note, and we cannot conclude this brief review better than quote the following impassioned passage:

"Thus the cup of joy or sorrow may be too full to hold without some expression of religious feeling; or man may find himself balked practically when he has done all that mortal man can think of; or he may bow over-awed in face of the mysteriousness of Nature and his place in it. The expressions of the religious mood may be primitive hardly rising above an appeal to magic or relapsing to that ancient system of belief, but they are sometimes so noble that they must be ranked among man's highest achievements. On the intellectual side, they often join hands with philosophy, on the emotional side with art, on the practical side with the endeavour after goodness; but the word 'religion' is misused if it does not imply a recognition of the mystical or spiritual. In some way and in some degree the religious man is always sending out tendrils towards the Supreme Reality; which he usually names to himself as God."

ELEMENTARY MICROTECHNIQUE. By H. A. Peacock. (Edward Arnold & Co., London, 1935). Pp. vi+200.

Mr. Peacock deserves to be congratulated on his extremely useful book on Microtechnique for beginners. The new book by Mr. Peacock, under review, gives us in the first few pages an exact and current idea of the structure of the cell including the emulsoid nature of protoplasm and also a brief account of the protoplasmic and metaplasmic bodies. After describing the objects of fixation (*viz.*, to obviate postmortem changes, to raise the refractive index, to increase the resistance of cells to solutions of varying osmotic pressures and to become amenable to stains), staining (where the physical and chemical theories are touched upon), differentiation, etc., the author gives a tabular statement (which is a ready reckoner) of the more important fixatives and their actions on cells and tissues. In the chapters on methods for specific purposes and uses of stains, he deals with the various fixatives and stains which can be used for the demonstration of the various organs of the different groups of animals and plants. The next chapter—Formulæ and Hints—is not only useful to the student working in a histological laboratory but also to a research worker. As the book aims at broadcasting only elementary microtechnique, the important subjects like fixation and differential staining for the protoplasmic and deutoplasmic bodies in the cells and also the various methods for the nerves and their peculiar endings are omitted. We would certainly welcome a book which gives us a comprehensive and authentic data for the clear exposition of the mitochondria and golgi bodies and various kinds of fats by select and differential staining.

The get-up of the book is excellent and we recommend it to every beginner in the field of microscopic anatomy.

The book contains three appendices in which valuable information is given on the sources and culture of material, the preservation of material and finally a complete bibliography.

L. S. R.

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CONFESSIONS OF A SCIENTIST. By Raymond L. Ditmars. (The MacMillan Co., New York, 1934.) Pp. xii+241. Price 10*s.* net.

Readers of Dr. R. L. Ditmars' *Reptiles of the World* will welcome this book which is, however, full of interest not only to the

scientist, but also to the general readers. It is true that there are not very many thrilling experiences recorded in this book, but the account of his scientific expeditions and his descriptions of the habits of some of the animals kept in the Zoological Park, New York, furnish extremely interesting and profitable reading. Dr. Ditmars has loving sympathy for the animals in his charge, is an intrepid explorer forgetting dangers in the midst of excitement, a remarkable power of observation and has a quaint manner of telling his experiences, and a combination of qualities which impart to his books the interest and wide circulation which they deserve.

The first chapter gives an account of the fruitless adventure in Panama in quest of bushmaster, a deadly viper with a head about the size of a man's fist, and the snake itself attaining nine feet. Instead of the dangerous prize he was seeking after, Dr. Ditmars obtained a baby boa constrictor in the cabin of the ship's captain. He accepts his failure in the spirit of a sportsman. The second chapter opens with an account of the author's talk on the "dragon" lizard, iguanas and a large tarantula. This is followed by the story of a hunt for crickets and cockroaches. The chapter is full of humour. Two chapters (III and XIII) are devoted to the treatment of the habits of vampire, a blood-licking bat of the tropical America and some new observations on their mode of locomotion on the ground, their feeding and their appearance after a full meal are recorded. Every chapter is fascinating. The author is also a film producer. To produce moving pictures of animals even in cages, especially of such dangerous ones as the mamba, is always attended by perilous excitement. Chapters VII, VIII and IX deal with this phase of activities of Dr. Ditmars. Chapters X and XI inform us about the use of cobra venom in the treatment of malignant tumours and of the poison of Tarantula in that of leprous growth. There is incidentally an account of the motion picture taken through the microscopes by Dr. Heinz Rosenberger, of the "good" and "bad" cells and the rôle they play in the production of abnormal tissues. The most amusing episode in the book is the successful theft of ten of the most beautifully coloured snakes in the collection and the offenders proved to be school boys whose zeal for science had temporarily obscured their sense of misdemeanour.

We scarcely remember reading a more interesting book in natural history. This one is packed with information over a wide range of subjects, and is told in a crisp style relieved by delicate touches of humour. It is an excellent companion to the author's bigger book *The Reptiles of the World.* We have read a most enjoyable book.

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A GERMAN-ENGLISH DICTIONARY FOR CHEMISTS. By Dr. Austin M. Patterson. Second Edition. 1935 (John Willey and Sons, Inc.; London, Chapman & Hall Ltd.) Price 15*s*.

Since its first publication in 1917, this book (so also its companion volume—the French-English Dictionary by the same author) has won the reputation of being invaluable to all English-knowing chemists. This cannot be otherwise, as there are few books which are equally handy, and yet provide such a useful assemblage of word-meanings.

The present edition comprises about 42,000 entries and as the author has mentioned in the preface, reflects the growth of the science. The author has been assisted in his task, among others by the staff of the *Chemical Abstracts* who, more than anybody else, are in a position to point out new German words and their meanings that have come into common usage in chemical literature. The blue additional sheets which were so conspicuous in the later impressions of the previous edition have now disappeared and the present vocabulary with its familiar flexible binding will be welcomed by all. A book so well-known to the Chemists, the world over, needs no elaborate notice; we have only to commend to their attention the new edition with a large number of new entries and numerous additional meanings of old words.

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CONTENTS.





# The King's Silver Jubilee.

THE twenty-fifth anniversary of the King's accession to the Throne was celebrated on Monday the 6th of this month with great rejoicing throughout the British Empire. In the official form of prayer and of thanksgiving prescribed for use on the auspicious occasion by the Metropolitan of the Province of India, there is a striking passage which comes nearest to the sentiments of the millions of King's loyal subjects and we reproduce it here:

> "It is very meet, right and our bounden duty that we should give thanks to Thee, O Lord, Holy Father, Almighty, Everlasting God, for that Thou wast pleased as on this day to set Thy Servant, Our Sovereign Lord, King George, Emperor of India, upon His Throne and hast protected him in days of sickness and of health throughout his reign of five and twenty years. For the example of increasing service set by him and by our gracious Queen Mary; for the strength and steadfastness bestowed on him and on the Nation in years of war and of manifold anxieties; for the love and loyalty borne to him by a great family of peoples in all parts of the world, we laud and magnify Thy glorious name. We bless Thee for increase in the knowledge of Thy marvellous works, in care for those who suffer from sickness or the lack of work, in desire that all men everywhere may live in peace and enjoy the fruits of their labour. For these and all other Thy mercies vouchsafed to us, O Father Almighty, We yield Thee unfeigned thanks."

Pomp and pageantry are survivals of dim antiquity but they are the only means of expressing the affection and loyalty of the people to their Sovereign. They are ephemeral. The historian who chronicles the events of the first quarter of the twentieth century has to portray them uninfluenced by the magnificent popular demonstrations. His Majesty's reign is an eventful one. Unfortunately the history of the last twenty years is a record of unfulfilled ideals and frustrated achievement in the political, economic and social aspects of national life. It is no doubt true that progress has been made in many fields of human endeavour, but it has promoted neither general welfare nor happiness. The Great War which broke out in the early part of His Majesty's reign, dislocated every department of public life in a manner for which history scarcely furnishes a parallel, and from the consequences of which the combined effort of all the statesmen have not rescued the world.

Practically every civilised state passed through great and terrible experiences during the past twenty years, and international

jealousies and economic rivalries have befogged the ideals for which the War was fought. The uniform cheerfulness and the unobtrusive readiness with which His Majesty has endeavoured to contribute to the solution of the most outstanding post-war problems will form an illuminating chapter in the history of this period. It would be pessimistic to maintain that there has been no progress, but the results have not been commensurate with the possibilities of establishing peace and concord which still elude the grasp of the world's ablest statesmen. However, the King's Jubilee message, "I dedicate myself anew to your service for the years that may still be given me," ought to fill the hearts of nations with fresh hopes for the achievement of international goodwill and amity. Their attainment depends not on the length of our prayers, nor on the skill in diplomacy, but entirely on the measure of self-sacrifice and the breadth and kindliness of humanity which we bring to bear on the solution of the difficult and intricate problems which confront the League of Nations and International Conferences. We have to substitute tne spirit of Christian humility for the language of patriotism in the settlement of world's affairs. The anniversary which was recently celebrated has a deeper significance for the British Commonwealth than a display of loyalty to the Crown: it is an invitation to the genius of the Empire to put forth fresh exertions in the international councils,

> "Till each man find his own in all men's good,
> And all men work in noble brotherhood,"

and for the achievement of this end, the King has offered his gracious co-operation in his broadcast message. The interest which foreign countries have shown in the celebration of the Silver Jubilee may be regarded as offering fresh hopes of international collaboration in reconstructing the economic fabric of the world.

In the whole history of civilisation, there is no more psychologically puzzling phenomenon than the situation in the year of the Silver Jubilee. All the nations as if by common consent have drifted from the path of peace, sanity and wisdom, and under the malign influence of the Political and Economic "Legion", they are precipitating down the Gadarene slopes to submergence. The Great War was fought to save civilisation, liberty and democracy; these ideals are smoke-screened by political passions and economic restrictions; the bitter lessons of militarism have only led the nations to sow fresh Dragon teeth; the ideals of the churc[h] and the claims of common humanity hav[e] almost been forgotten in the transactions o[f] international affairs. It is yet possible that th[e] auspicious anniversary of the Silver Jubile[e] may be the occasion for the birth of a ne[w] and moving hope to cement internationa[l] sympathy, confidence and friendship, without which the perplexing problems which no[w] confront civilisation will finally overwhel[m] humanity, if they are not wisely handled t[o] compass a higher unity and a broade[r] synthesis. In the political and economi[c] conflicts, we forget the essence of huma[n] nature, its scale of values, the meaning an[d] purpose of social existence, its desires an[d] aspirations.

The multiple contradictions of the prese[nt] stage of civilisation must be due to the fa[ct] that while the progress of science has e[n]dowed man with almost fabulous powe[r] for controlling his environment and refinin[g] his nature, it has in the sphere of thoug[ht] apparently dissociated the human spir[it] from the world values in which inevitabl[y] it has its existence. Viewed from a supe[r]ficial standpoint, science would appear t[o] have come up against the meaning an[d] purpose of human nature and this confusi[on] has affected other fields of thought an[d] activity so completely that further progre[ss] in the outer and inner life seems to b[e] barred unless a bridge is thrown across th[e] chasm which separates faith and action an[d] ideals and practice. The increasing appr[e]ciation of the functions of science in civi[li]sation may be hoped to remove such ant[i]nomies which generally arise from fal[se] emphasis on values and from treatment [of] incomplete or inaccurate premises as if the[y] are whole and final. A great psychologic[al] event which has its roots in the heart of th[e] nation has often deflected the current [of] public affairs, and the Silver Jubilee, whi[ch] has stirred the imagination of the who[le] Empire, may, if its spirit is understoo[d] perhaps prove to be the turning point of th[e] fortunes of the greatly distracted an[d] perplexed world. In this noble task, th[e] genius of the Commonwealth is behind t[he] Sovereign.

His Majesty as the inheritor of the ri[ch] traditions of the Throne and of the achiev[e]ments of the British race is a representati[ve] of the national history. He is the corne[r]stone of the Empire. The affection an[d] esteem in which his subjects hold H[is] Majesty and the singular popularity whi[ch]

he enjoys throughout the world by the sympathy and tenderness with which he approaches international problems are an invaluable asset for the Empire. The world can pay no nobler tribute to its greatest monarch on this auspicious occasion than re-explore the possibilities of achieving international peace, prosperity and contentment. All the nations of the world have, in a smaller or greater measure, contributed to disorganise the international economic structure and to arouse mutual suspicions, jealousies and passions; and in rehabilitating international life on the basis of goodwill, truthfulness, honesty and amity, the contribution must be made in a spirit of Christian humility. The different races have to make large sacrifices in the interests of humanity and live as a brotherhood of nations and not divided into warring camps.

It is in this spirit of broad kindliness and sympathy that His Majesty's reply to the Dominions representatives is conceived and it is worth reproducing in full :

"There is a word which gladdens me, more especially when I hear it used by friends from the overseas, many of whom say, when they visit this country "they are coming home". It is in this spirit that the Queen and I meet you to day, you who represent the vast territories, the Dominions, the Colonies, the protectorates and my peoples in India and the dwellers in the countless Isles of the sea from the Pacific to the homewaters. We greet the Prime Ministers of the Dominions, now equal partners in the Empire, and thank them for the addresses from their Parliaments which they have handed to me. We welcome one and all to our home.

"Eventful your visit cannot fail to be and I trust it will be happy also. When the time comes for you to return, I would ask you to take back, each to his own people, a message of affection to every member of this great family, of which I am so proud and thankful to be the head; and a message of deep gratitude for the loyal and kind words which you have spoken on their behalf. You all, who are here to-day and who hold responsible positions, will best know what an inspiration and encouragement your words are to me to continue the task which, 25 years ago, I set myself to do. Before I succeeded my father, the Queen and I had the privilege of studying firsthand the Dominions Overseas and India. We were fellow-travellers then, as now, comparing notes and sharing impressions. We treasure these memories and keep them alive. Moreover, what we forget, our four sons are now able to recall. Many years before our happy partnership began, I had, as Midshipman, sailed the seven seas and I realised early that the Empire has many climes but one spirit.

"I regard this as a unique gathering where we can tell one another our successes as also our failures and mistakes, but there can be no sharp criticism nor vain regrets, for we are, in sympathy, one with another, conscious that we have acted according to our lights for the good name and ordered prosperity of the family. We are some time told that we are lacking logic, and that our political institutions are loose and undefined; but I look back on the trying and testing time through which we have passed and wonder whether a less flexible system would have withstood the strains to which we have been subjected. With common-sense and goodwill as our shield buckler, we have kept in spite of all difficulties our heritage—liberty alike for the individual and our many constituent races. The numberless and invisible ties, sentiment and tradition, which bind us together, are indeed delicate, but many strands make the cable strong to bind in times of adversity. It is my prayer, no less than my firm belief, that this bond of spirit may prove also the bond of a peace. Some of you are, with a few happy exceptions, about my own age and I pray for the continuance of God's blessings on your labours. With His help, I will work on with you in the years that remain for that object which has ever been next to my heart—welfare of the mother country, the Dominions Overseas and India, their happiness and their good repute."

## Coloured Races in South Africa.

THE news of the appointment of a Commission of Enquiry by the Ministry of the Interior, Fusion Government of South Africa, for the investigation of social, educational and economic needs of the Cape "coloured" community, will be welcomed by all those interested in the question of race and colour. The "coloured" races are the admixture of the white European and the native Hottentot, Negro, and Malays. The "coloured" man is a slum dweller in the town. The death rate is 2·4 times as high among the "coloured" race, as among the white; the death rate due to tuberculosis among the European is 0·68 per 1,000 while it is 4·69 per 1,000 among the non-European. Bad housing, insufficient food and miserable industrial conditions, are responsible for the heavy death toll and a searching enquiry into the causes of the unhappy state of affairs is imminent. The appointment of the Committee indicates that thoughtful South Africans are becoming increasingly uneasy with the conditions of the unfortunate "coloured" races and that they are out to eradicate the distress among them.

# Light Scattering and Raman Effect.

By S. Bhagavantam.

### Introduction.

THE discovery of the Raman Effect in 1928, has created a new chapter in the branches of spectroscopy and molecular physics with the result that the phenomenon of light scattering, which interested only a few men of science in the past, has become the subject of intensive investigation in recent years in various centres of research. The extreme rapidity with which the concerned literature has grown renders it very difficult to present a concise and complete picture of the advance that has been made in different branches of physics and chemistry. In a few publications, well known to the workers in the field of light scattering, Kohlrausch,[1] Weiler,[2] Placzek[3] and others[4 5] have successfully attempted to give authoritative and up-to-date summaries of the subject from time to time. The purpose of the present article is to give a very brief account of the discovery and the development of Raman effect and its relation to Rayleigh scattering with special emphasis on the more important fields of research that have recently been opened up.

### Rayleigh Scattering.

The idea that the blue colour of the sky is the result of the scattering of sunlight by the molecules of the atmosphere was first put forward by the late Lord Rayleigh who also ventured the s ggestion that the known imperfect polarisation of sky-light might in part be due to a lack of spherical symmetry of the molecules. All subsequent work supported this theory of the blue sky, and experimental investigations by Cabannes, the present Lord Rayleigh and others furnished confirmation of it by observations of such scattering made in the laboratory. The recognition, by Professor Raman, that the blue of the oceanic waters is another natural optical phenomenon which presents a close analogy to the blue of the sky was another important step in the history of the subject. These fundamental observations were soon followed by intensive and detailed experimental investigations in India and other countries which were intended to discover the various laws governing the phenomenon of light scattering. The first important observations relate to the fact that the light scattered in a direction transverse to the incident beam invariably exhibits a state of partial polarisation, the degree of depolarisation or the ratio of the horizontal to the vertical components being characteristic of the substance under investigation and its state of aggregation. As the subject advanced, it has become clear that this phenomenon is of a very general nature involving the solution of fundamental questions regarding the interaction of matter and radiation and a systematic study of substances covering the widest range of physical states and conditions has been undertaken by Raman and his collaborators at Calcutta. Such investigations revealed that there are two types of scattering which may respectively be termed the density scattering and the orientation scattering. The density scattering arises from the existence of a molecular chaos in the medium giving rise to local fluctuations in density and its intensity is therefore profoundly influenced by temperature, state of aggregation, compressibility and such other factors which characterise the medium as a whole. This type of scattering is completely plane polarised in the transverse direction. The orientation scattering on the other hand owes its origin to an optical asymmetry of the molecules which constitute the medium and orientate freely in it and is thus determined *primarily* by a property of the individual molecules and not the medium itself. This type of scattering is nearly completely unpolarised.

The earlier investigations based on both visual and photographic methods, while thus leading to a clear recognition of the fact that the scattered beam in general consists of two parts which are fundamentally different, also led to the belief that these two types are superposed on each other resulting in an admixture of a completely polarised beam with a partially polarised beam. No indications were forthcoming which suggested that a change of wavelength is possible in the process of scattering

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[1] K. W. F. Kohlrausch, "Der Smekal—Raman Effekt" (Julius Springer) and other articles.

[2] J. Weiler, *Physikal. Z.*, 1932, 33, 489.

[3] G. Placzek, *Handbuch der Radiologie*, 1934, 2nd Edn., 6, 205, and earlier communications.

[4] S. Bhagavantam, *Ind. Jour. Phys.*, 1930, 5, 237.

[5] J. Hibben, *Chem. Rev.*, 1933, 13, 345.

and no attempts were made to experimentally separate the different types of scattering. Progress in the subject was hampered by the limitations inherent in the methods of observation and it was not until the discovery of the Raman effect that the full significance was realised of the above results and of the necessity of separating the different types of scattering.

### RAMAN EFFECT AND ITS RELATION TO RAYLEIGH SCATTERING.

The earliest indications of the existence of a new type of scattering are available from the investigations of Ramanathan at Calcutta in 1923. By interposing a filter in the path of the incident beam which consisted of a concentrated track of sunlight, he limited the spectral range of illumination and found that most liquids exhibited a feeble trace of scattering in the transverse direction even when examined through another filter complementary to the one placed in the incident track. This observation gave an unmistakable indication of a new type of scattering which differed from the incident beam in having an altered wave-length and a persistence of this phenomenon even after the liquids had been carefully purified by repeated distillation showed that it did not arise from any impurities in the manner of fluorescence or otherwise. The necessity of spectroscopically separating from the general scattering the track observed through the complementary filter soon became clear. It was realised that the scattered beam visually seen was a composite effect in a much wider sense than was till then presumed, as it consisted of a whole spectrum of different wave-lengths even when the incident light was restricted to a narrow spectral range. A mercury arc was substituted in the place of filters and sunlight and a spectrograph in the place of the eye. Systematic investigations carried out by Raman with a variety of substances revealed the presence of a number of sharp lines or bands which were not present in the light of the mercury arc.[6] This forms the starting point of the study of the Raman effect and the experiments were immediately extended to a large number of liquids, solids, gases and vapours and in a few months after the discovery it was found that one of the most powerful and yet easily accessible fields of research in the study of the structure of molecules had been opened up. The technique was greatly improved and the general features characterising the Raman spectra were rapidly discovered in the following years.

Besides the lines originally present in the incident radiation the scattered spectrum usually consists of new lines or in some cases bands and unresolved continuous radiation shifted from a parent line by different extents. Each line in the incident spectrum, if of sufficient intensity, gives rise to its own set of lines and bands and the frequency shifts are independent of the nature and position of the incident radiation and are therefore only characteristic of the particular material studied. The individual Raman lines show generally great differences in their intensity and width and their number and variety are found to increase with increasing complexity of the molecule. Just as the Rayleigh scattering exhibits depolarisation, the Raman lines and bands exhibit a variety of polarisation characters. Some of them are strongly polarised and others highly depolarised. Attempts to interpret these apparently different types of Raman scattering (sharp lines, broad lines, diffuse bands, continuous spectrum, unresolved wings associated with the original lines, etc.) and their widely different intensity, structural and polarisation characters revealed an intimate connection of these features with the structure of the scattering molecules and the mechanism of the phenomenon of scattering. Subsequent experimental and theoretical investigations have resulted in a considerable advance of our knowledge regarding these questions.

### GENERAL THEORY OF THE RAMAN EFFECT.

The simplest picture that may be obtained of the production of a Raman line has been proposed by Raman himself[3] and consists in regarding the collision between the molecule and a light quantum as satisfying the law of conservation of energy. The equation

$$h\nu + \text{Molecule (normal)} \rightleftarrows h\nu^* + \text{Molecule (excited)}$$

represents the passage of a molecule from a normal state to an excited state the energy of the light quantum diminishing from $h\nu$ to $h\nu^*$ if the transformation proceeds from left to right and *vice versa* if it proceeds in the opposite direction. As a result of the collision, the molecule is left in a state of altered energy and the light quantum as it is scattered, supplies or takes up the difference

[6] C. V. Raman, *Ind. Jour. Phys.*, 1928, **2**, 387.

of energy as the case may be. This manifests itself as a Raman line shifted from the position of the parent line by a distance equivalent to the energy change. Theoretically it is possible to conceive of the molecules changing either their electronic, vibrational or rotational energy alone or any combinations of these with the result that one should expect different and complicated types of Raman scattering which are respectively analogous to the cases of electronic (visible and ultraviolet), vibrational (near infra-red) and rotational (far infra-red) spectra of molecules. This implies the appearance of very complicated Raman spectra which may be directly correlated with the absorption spectrum of the substance in the visible region if we are dealing with electronic transitions and in the infra-red region if we are dealing with vibrational or rotational transitions. In practice, however, it is the latter type that are frequently met with in Raman spectra* and we need consider only these in the following pages.

After a few preliminary investigations, it soon became clear that there is no exact one to one correspondence between Raman lines and the infra-red absorption spectra and it was concluded that the simple equation, while indicating that an energy change similar to the one occurring in direct absorption is also responsible for the production of a Raman line, is not adequate enough to give a complete picture of the phenomenon. The primary defect of this equation is that it does not tell us anything about the relative probability of each one of the several transitions that are possible between the various stationary states of a molecule if it possesses more than two such states. In other words we cannot anticipate the relative intensities of various Raman lines.

A satisfactory explanation of these and other facts on the basis of the Kramers-Heisenberg dispersion theory has been worked out by Langer[8], Hill and Kemble[9], Van Vleck[10], Manneback[11 12], Placzek[3] and others and it was evident from the investigations of these authors that the selection rules controlling the appearance of a Raman line are very different from those that favour the production of infra-red absorption and as such a certain lack of correspondence between them should be expected. The general results of the Kramers-Heisenberg dispersion theory and its detailed application to diatomic gaseous molecules are contained in a very important paper by Manneback[11] who, besides furnishing for the first time quantitative expressions in certain simple cases for the intensity and polarisation characters of Raman lines, brought out a very fundamental relationship between the optical properties of the molecule and the phenomenon of Raman scattering. He showed that just as the intensity and depolarisation of the Rayleigh scattering are intimately connected with the refractivity and anisotropy of the scattering molecules, so also the intensity and depolarisation of the Raman scattering are consequences of the existence of a finite variation of these quantities (refractivity and anisotropy of the molecules) with varying nuclear distances.

Exactly similar conclusions have been reached from different points of view by other investigators[13 14] and the fundamental ideas underlying the theory have been successfully extended to polyatomic molecules by Placzek[3] who worked out in great detail the intensity and polarisation characters that are to be expected for various lines due to molecules possessing different types of symmetry.

## VIBRATIONAL RAMAN LINES: PROBLEMS RELATING TO THE STRUCTURE OF MOLECULES.

As has already been remarked, the number and variety of Raman lines given by a substance increases rapidly with the complexity of the molecule and it becomes increasingly difficult to interpret the results in a complete and satisfactory manner. Nevertheless, conclusions of outstanding significance have been drawn by Ganesan and Venkateswaran[15], Daure[16], Dadieu and

* The electronic type of Raman Effect has been detected only in one favourable case (See Reference 7). The reason for such an infrequent occurrence of this type is presumably the large change of energy that is usually involved.

7 F. Rasetti, *Phys. Rev.*, 1929, **34**, 548.

8 R. M. Langer, *Phys. Rev.*, 1929, **33**, 1097.

9 E. L. Hill and E. C. Kemble, *Proc. Nat. Acad. Sci.*, 1929, **15**, 387.

10 J. H. Van Vleck, *Proc. Nat. Acad. Sci.*, 1929, **15**, 754.

11 C. Manneback, *Z. f. Phys.*, 1930, **62**, 224.

12 C. Manneback, *Nature*, 1930, **125**, 88.

13 S. Bhagavantam, *Ind. Jour. Phys.*, 1931, **6**, 331.

14 J. Cabannes and Y. Rocard, *J. Phys. et le Rad.*, 1929, **10**, 52.

15 A. S. Ganesan and S. Venkateswaran, *Ind. Jour. Phys.*, 1929, **4**, 195, and subsequent papers.

16 P. Daure, see numerous papers by him in *Comptes Rendus* and *Annales de Physique*.

Kohlrausch[17], Bonino and Brull[18] and others from a study of the Raman spectra of complicated organic and inorganic molecules. The identification of certain frequencies as characteristic of definite groups or linkages has been of immense help in determining the constitutions of molecules. The problems of distinguishing different isomers with the help of Raman spectra, of following physico-chemical transformations such as association, dissociation, polymerisation, hydrate formation, esterification and numerous other changes which involve an alteration in the structure of the scattering unit have usefully engaged the attention of workers in this field.

Even more fruitful are the investigations relating to simpler substances and in certain cases detailed studies have shown how remarkably the ultimate structure of the molecule comes into evidence in the Raman effect. The most striking case has been that of hydrogen and the pioneer work of McLennan and his collaborators[19] with this substance has furnished the first experimental proof of the existence of two forms of hydrogen and of the process of slow transformation of one form into the other at liquid hydrogen temperatures.

Subsequent investigations by Rasetti and others[20] with many simple gases have led to a direct and accurate measurement of their vibration frequencies. Special mention may be made here of the cases of $CO_2$, $CS_2$, $N_2O$ and $SO_2$. These triatomic molecules, in view of their simplicity, have been the subject of intensive investigations and evidence is to-day available which definitely decides the structure of each one of these molecules. Only a brief mention will be made here of the main results. The spectra of $CO_2$ and $CS_2$ are very similar in that two prominent and closely situated Raman lines are observed, each of which has in addition a faint component. The strongest line in each case corresponds to a symmetric expansion of the molecule and is not represented in infra-red absorption. The two principal infra-red absorption bands on the other hand at 675 and 2350 cm.$^{-1}$ in $CO_2$ and 397 and 1523 cm.$^{-1}$ in $CS_2$ are not represented in the Raman effect.* All these facts point to a linear symmetrical structure of these two molecules. The case of $N_2O$ is on a different footing as the strongest line in the Raman-spectrum is represented by a weak band in the infra-red absorption and one of the principal absorption bands at 2226 cm.$^{-1}$ is also represented in the Raman-spectrum quite unlike $CS_2$ and $CO_2$. This indicates an unsymmetrical linear structure for $N_2O$.† Contrary to all these cases, the triangular shape and the consequent polarity of the $SO_2$ molecule come into evidence in its Raman-spectrum in a striking manner as it consists of one sharp line and two diffuse bands all of which are represented in the infra-red absorption.

Investigations with slightly more complicated molecules of the type $AX_3$, $AX_4$ and $AX_6$ besides furnishing for the first time a direct measure of the fundamental vibration frequencies in certain cases have revealed interesting relationships between the nature of the constituent atoms and the binding forces. Extensive theoretical calculations[21 22 23 24 25 26 *et al*] made with a view to quantitatively account for the number and actual values of the observed frequency shifts in the Raman spectra of these molecules have revealed the necessity of taking into account a variety of interatomic forces and the results obtained are of special interest from the point of view of the building up of molecules.

## INTENSITY AND POLARISATION CHARACTERS OF RAMAN LINES.

All the above conclusions regarding the structure of molecules have received

[17] A. Dadieu and K. W. F. Kohlrausch, A series of about 40 papers have been published by these authors and their collaborators mainly in *Sitz. Akad. Wiss., Wien.*

[18] G. B. Bonino and L. Brull, See numerous papers by these authors in *Gazetta Chimica Ital.*, and *Rendiconte Acad. Lincei.*

[19] J. C. McLennan, *Trans. Farad. Soc.*, 1929, **25**, 797.

[20] R. G. Dickinson, R. T. Dillon and F. Rasetti, *Phys. Rev.*, 1929, **34**, 582, and other papers by Rasetti himself.

* There is a very weak band at 400 in the Raman spectrum of liquid carbon disulphide. This should be regarded as an exception.

† That the structures of $CO_2$ and $N_2O$ differ in that one is symmetrical while the other is unsymmetrical is also evident from the fact that the phenomenon of alternating intensities is seen in the rotation spectrum of $CO_2$ and not $N_2O$.

[21] Urey and Bradley, *Phys. Rev.*, 1931, **38**, 1969.

[22] Vedder and R. Mecke, *Z. f. Phys.*, 1933. **86**, 137.

[23] O. Redlich, F. Kurz and P. Rosenfeld, *Z. f. Physikal. Chem.*, 1932, **19**, 231.

[24] D. M. Yost, C. C. Steffens and S. T. Gross, *Jour. Chem. Phys.*, 1934, **2**, 311.

[25] N. S. Nagendranath, *Ind. Jour. Phys.*, 1934, **8**, 581; and *Proc. Ind. Acad. Sci.*, 1934, **1**, 250.

[26] G. B. B. M. Sutherland and L. M. Dennison, *Proc. Roy. Soc.*, 1935, **148**, 250.

independent confirmation from a study of the intensity and polarisation characters of the various lines in Raman spectra. In spite of the more numerous experimental difficulties in the way of an accurate study of these features, results of fundamental and far-reaching importance have been obtained. Definite progressions in the intensity and polarisation characters of the corresponding lines in the Raman spectra of analogous molecules such as the trichlorides or the tetrachlorides have been discovered and a correlation is found to exist between the characters of a line and the type of symmetry of the oscillation giving rise to it.[3] An application of the polarisability theory by Placzek to special and simple cases like $CO_2$ and $CS_2$, whose vibrational spectra have been the subject of important theoretical investigations by Fermi, Dennison and Placzek, has raised several fundamental issues. This resulted in a detailed experimental study by recent investigators of the intensity and polarisation phenomena in the Raman spectra of these molecules [27 28 29 30] and a more or less complete and satisfactory explanation is now available of the origin of the numerous lines exhibited by them. It has already been remarked that the presence of a weak, broad and depolarised Raman line at 400 cm.$^{-1}$ in liquid carbon disulphide should be regarded as an exception.[31] A feature of these molecules, which is of further interest, is the existence in them of a special type of resonance giving rise to Raman lines which are to be regarded as overtones. The relatively low energy of the first vibrational state is also responsible for the presence of Raman lines which represent transitions from the first excited state to a higher vibrational energy level. These characters are somewhat exceptional as they are not frequently met with in Raman spectra.

Investigations of this type have also been extended to more complicated molecules and results of great theoretical importance obtained in connection with the ratio of intensities between stokes and antistokes Raman lines, dependence of the intensity and polarisation of a Raman line on the frequency of the exciting radiation, variation of intensity and polarisation within the structure of the line itself and other allied problems.

### Rayleigh Line: Its Fine Structure and Accompanying Wings.

It has already been mentioned that the Raman spectra fall into two major classes which arise respectively from the vibrations and rotations of the molecules. Till now we have dealt with only the former type of Raman scattering. The latter type manifests itself as closely spaced lines or unresolved wings in the neighbourhood of the Rayleigh line. It is for this reason that the Rayleigh lines obtained in the Raman spectrum of a substance are not usually sharp even when the incident light is strictly monochromatic. Such a broadening or diffuseness has been first recognised in liquids by Raman and Krishnan[32] who associated it with rotation of molecules. Subsequent investigations relating to this aspect of the subject were however confined to gases and have revealed the presence of similar wings in their scattered spectra but contrary to the case of liquids these could be resolved into separate and closely spaced lines under suitable conditions and definitely attributed to the rotation of molecules as their positions could be correlated with the moments of inertia of the scattering units. The very admirable work of Rasetti, Wood and others on the Raman spectra of simple gaseous molecules has furnished convincing proof of the above statements. Amongst the many notable results obtained by these investigators mention may be made of the phenomenon of alternating intensities amongst the rotation lines of hydrogen and nitrogen gases. This discovery has led to an accurate and direct determination of the relative populations of the two different kinds of hydrogen molecules and to a recognition of the important fact that the nitrogen nucleus, while possessing a spin moment of one Bohr unit, conforms to the Bose-Einstein statistics and not to the Fermi-Dirac statistics.

In liquids, on the other hand, detailed investigations on the subject were lacking for a long time and the diffuse wings noticed on either side of the Rayleigh lines were attributed to the rotation of liquid molecules only by analogy with the case of gases. Systematic experimental studies carried out

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27 A. Langseth, J. U. Sorensen and J. R. Nielsen, *Jour. Chem. Phys.*, 1934, 2, 402.

28 A. Langseth and J. R. Nielsen, *Phys. Rev.*, 1934, **46**, 1057.

29 I. Hansen, *Phys. Rev.*, 1934, **46**, 122.

30 A. Veerabhadra Rao, under publication.

31 S. Bhagavantam, *Ind. Jour. Phys.*, 1932, 7, 79.

32 C. V. Raman and K. S. Krishnan, *Nature*, 1928, **122**, 278.

by a number of investigators[33 34 35 36 37 38] have recently brought to light some significant and fundamental differences between the wings that are met with in liquids and those obtained in gases. In most liquids, the distribution is such that the wing starts with a maximum intensity at the centre itself and extends to much longer distances than is expected on the basis of Maxwellian distribution of rotational energies. That such a phenomenon cannot be explained as due wholly to the rotation of molecules and that the patterns in liquids should be regarded as superpositions of a rotational Raman effect on another and more complex spectrum characteristic of the solid state has first been pointed out by the present writer.[36] Striking results in this direction have recently been obtained by Gross and Vuks[39] who showed that the wings observed in liquid benzene, naphthalene and diphenyl ether are replaced by broad bands when the Raman spectrum of these substances is studied in the solid state. It is suggested that these bands broaden out into a continuous spectrum in the liquid state and the observed wings result from a superposition on this of the pure rotation pattern. This result implies that some characteristics of the solid are preserved beyond the melting point of the substance and is of great significance as it opens up a new line of investigation which promises to throw light on the important question of the nature of the liquid state.

Intimately connected with this aspect of the subject is the phenomenon of fine structure of the Rayleigh scattering in liquids discovered by Gross[40] who examined the scattered lines under high dispersion and found a whole series of satellites on either side of a central line which is itself in the position of the incident radiation. Several investigators[41 42 43 44 45] have subsequently examined this question but the results reported in most cases were unsatisfactory and indecisive. Recent systematic investigation of this phenomenon, undertaken by Raghavendra Rao at Bangalore, has yielded very significant results. Besides the undisplaced line, only two components have been located one on either side of it. The positions of the displaced components and the effect on the same of changing the frequency of the incident radiation are in satisfactory agreement with the predictions of the Einstein-Brillouin theory of light scattering in solids. The presence of central undisplaced component is not however contemplated in this theory and should not appear if we are dealing with solids. Its presence is characteristic of the light scattered by a gas and the results therefore indicate that the liquid state resembles a solid in certain respects and a gas in certain other respects. The general picture obtained of the liquid state from a study of the fine structure of Rayleigh lines is thus more or less the same as that deduced from independent investigations relating to the phenomenon of wings. It is obvious that both these lines of work are of fundamental significance and much remains to be done in this direction.

## CONCLUSION.

In conclusion it must be pointed out that in the foregoing paragraphs, no attempt has been made to present a complete picture of the state of the subject but only a brief mention has been possible of the many outstanding results that have so far been obtained. Although the direct and simple problems that arise from a study of light scattering have already been successfully tackled, there remain yet to be investigated the more recondite phenomena such as the effect of increasing pressure and density on the Raman spectra of gases, the relation of such effects to the phenomena exhibited by dense media such as solids and liquids, the nature of the solid and liquid states, the relation of the amorphous state to these and numerous other problems of this type. Recent investigations have shown that a study of the Raman effect under high dispersion, light gathering power and other suitable conditions constitutes one of the most powerful lines of attack in the solution of the above problems and the future development of the subject will undoubtedly proceed on these lines.

33 J. Weiler, *Z. f. Phys.*, 1931, **68**, 782.
34 A. Rousset, *J. Phys. et le Rad.*, 1932, **3**, 555.
35 S. P. Ranganadham, *Ind. Jour. Phys.*, 1932, **7**, 353.
36 S. Bhagavantam, *Ind. Jour. Phys.*, 1933, **8**, 197.
37 S. Bhagavantam and A. Veerabhadra Rao, *Ind. Jour. Phys.*, 1934, **8**, 437.
38 A. Veerabhadra Rao, *Ind. Acad. Sci.*, 1934, **1**, 274.
39 E. Gross and M. Vuks, *Nature*, 1935, **135**, 100; and 1935, **135**, 431.
40 E. Gross, *Z. f. Phys.*, 1930, **63**, 685; and subsequent papers.
41 J. Cabannes, *Trans. Farad.* Soc., 1929, **25**, 800; and subsequent papers by himself and his collaborators.
42 M. Vacher, *Compt. Rend.*, 1930, **191**, 1121.
43 Rafalowski, *Nature*, 1931, **128**, 495.
44 E. H. L. Meyer and W. Ramm, *Physikal. Z.*, 1932, **33**, 270.
45 B. V. Raghavendra Rao, *Proc. Ind. Acad. Sci.*, 1934 and 1935, **1**, 261 and 473.

# Hydraulic Seismographs.

By S. K. Banerji.

FOR the last three years we have been experimenting on a type of seismographs which have several interesting features. These instruments are based on a method of hydraulic magnification and damping first enunciated by Prof. Kapitza in connection with his experiments on magnetization in very strong magnetic fields. The earlier forms of seismographs constructed on this principle were described in a note in *Nature*, page 547, Vol. 131, 1933 ; they were not found very satisfactory for the recording of distant earthquakes as owing to their low free periods (about 2 or 3 seconds) and large constraints, they were not sufficiently responsive to slowly varying impulses. They were, however, found to be highly sensitive to quick period movements of the ground, such as would be produced by dropping a weight, or a buried "explosion", and being portable were considered to be a very suitable type of instruments for geo-physical prospecting.

Since writing the above note in *Nature*, the instrument has been considerably improved. The earlier form of the apparatus for the recording of the vertical component of the ground movements consisted of a cylindrical cup whose lower face was closed by a metal diaphragm, and a narrow tube was attached horizontally fitting a small hole in its side, in which a small mirror was suspended from an axle (Fig. 1). A cylindrical jacket covered the cup all round except the diaphragm at the bottom. Some highly viscous oil, such as paraffin or castor oil, was poured into the inner chamber and the diaphragm was then loaded by attaching a weight of about a kilogram or more to a rod passing through its centre. The vertical component of the ground movements sets up oscillations in the membrane and forces the oil to move to and fro through the narrow tube and thus gives a large oscillatory angular motion to the mirror which is recorded photographically.

The apparatus is shown diagrammatically in Fig. 1.

ABCD is the inner chamber, of which the lower face, CD, consists of a thin metal diaphragm of 36 S.G. EFGH represents the outer vessel. T is a narrow tube in which a small mirror M is suspended from a horizontal axis. G is a glass window in the outer vessel to admit light for illumination. A beam of light from a collimator telescope is made to fall on the mirror M and is reflected on a photographic paper wrapped

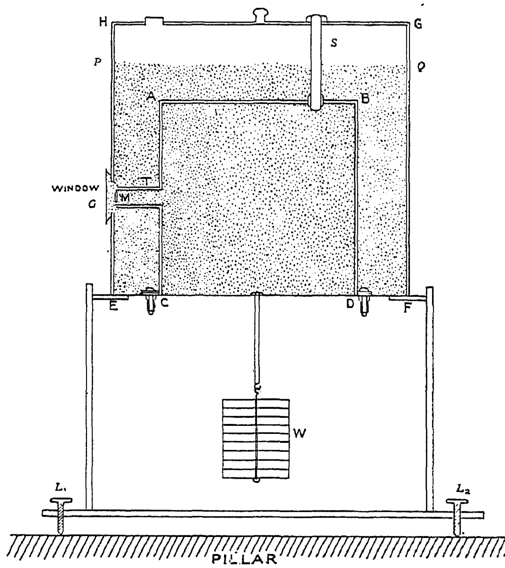



Fig. 1.

round a recording cylinder. W is the weight attached to the diaphragm. S is a tube through which some viscous oil, such as paraffin or castor oil, is poured and the chamber filled up to a height PQ so that the inner vessel is completely full of oil.

When the diaphragm CD moves upwards, the oil is forced out through the narrow tube T, the motion in the tube being magnified in the ratio of the area of the diaphragm to that of the section of the tube. The mirror therefore acquires a large angular motion about a horizontal axis. The whole instrument rests on a cast iron platform with three levelling screws $L_1$, $L_2$, $L_3$.

In one instrument used in these experiments, the following were the constants :—

| | |
|---|---|
| Diameter of inner vessel | = 15 cm. |
| Height of inner vessel | = 15 cm. |
| Diameter of diaphragm (tin) | = 15 cm. |
| Thickness of diaphragm (tin) | = 0·019 cm. |
| Diameter of outer vessel | = 23 cm. |
| Height of outer vessel | = 23 cm. |
| Diameter of tube | = 1·9 cm. |
| Weight suspended | = 1 kg. |
| Mechanical magnification | = 60 times. |
| Optical magnification | = 10 times. |

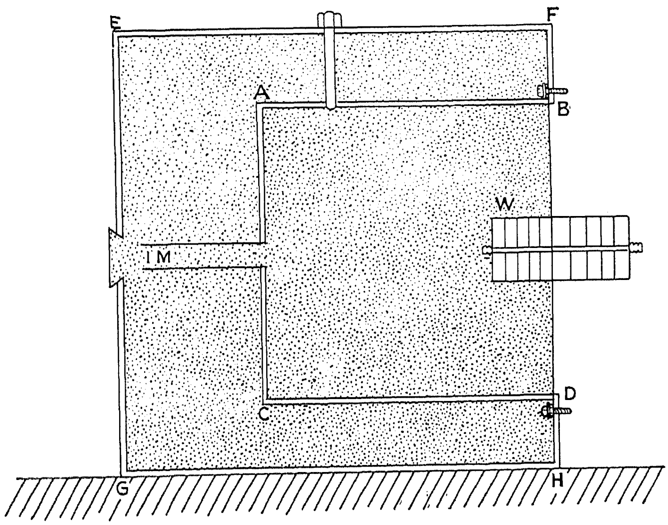
| | |
|---|---|
| Total magnification | =600 times. |
| Period | = 2·3 secs. |
| Damping ratio | = 5 : 1. |

The oil used was castor oil.

Using a brass diaphragm of thickness 0·02 cm., a period of 2·5 secs. and a damping ratio of 5 : 1 was obtained.

If the vessels are of brass, castor oil (even when pure) produces chemical action and it slowly becomes green. To avoid this, the vessels were all nickel-plated.

For illumination, a collimator telescope with a 6-volt straight filament lamp was used. The recording apparatus consisted of a vertical cylinder, of length 6 inches and diameter 6 inches, rotating and at the same time moving vertically downwards along a spiral. The cylinder makes a revolution once every hour and undergoes a downward displacement of about a centimetre during obtained by cutting off the light for 2 or 3 secs. every minute by means of the usual electromagnetic shutter. An instrument of this kind was kept in action for several months. During the period, the instrument gave good records of microseisms but the records of distant earthquakes were not satisfactory. Experiments were therefore made with membranes of other kinds. A leather membrane of diameter 6 inches and thickness 0·06 cm. such as is used in musical drums would increase the period to about 3·2 seconds, and the damping ratio to 7 : 1. The instrument becomes more sensitive to earthquake waves but the "zero" remains unstable until the membrane settles down to some steady conditions. Usually, however, when the instrument is used in this form leaks occur in the membrane after a few weeks' use. The same remarks apply also to rubber




PILLAR

**Fig. 2.**

the interval. The speck of light on the photographic paper wrapped round the cylinder traces a spiral. The motion of the recording cylinder down the spiral is controlled by a clock. The motion really occurs under gravity but the clock acts as a brake. As the cylinder rotates in the same direction as the minute hand of the clock, the falling cylinder keeps the clock going. No power is required from the clock, and an ordinary cheap spring-driven clock may be used for the purpose. Time mark is membranes. A rubber membrane of diameter 15 cm. and thickness 0·08 cm. gives a period of 3·4 seconds and a damping ratio of 7 : 1. If a membrane of larger diameter is used, the period is increased, but it does not always oscillate in the gravest mode.

A similar arrangement was adopted for the recording of horizontal component of the ground movement (Fig. 2). The membrane, BD, is in the vertical plane and is loaded at its centre by two symmetrical weights fixed on either side of a horizontal rod.

The frequency N of a loaded diaphragm with water on one side and a mass $m$ at the centre is given by

$$N = 0 \cdot 4745 \frac{hc}{a^2} \frac{1}{\sqrt{(1+\beta+5m/M)}},$$

where $h$ is the thickness of the diaphragm, $c$ the velocity of elastic waves in an infinite thin plane of the same material, $\beta = 0 \cdot 668 \rho' a / \rho h$, $\rho'$ being the density of liquid, $\rho$ density of material of the membrane, $m$ mass suspended from centre of diaphragm and M the mass of the diaphragm. For a rubber membrane, taking $E = 10 \times 10^{11}$ dynes/cm.$^2$, $a = 7 \cdot 5$ cm., $h = 0 \cdot 021$ cm., $\sigma = 0 \cdot 35$, $\rho = 0 \cdot 9$, $\rho' = 1$, $c^2 = E/\rho\ (1 - \sigma^2)$, we get the period equal to about $1 \cdot 5$ seconds. The observed period is $3 \cdot 4$ secs. for a rubber membrane of this type. The smaller value given by the above formula is due to its not taking full account of all the physical effects. If we take account of the fluid and its movement into account, then, a more accurate formula for the frequency is

$$N^2 = \frac{1}{4\pi^3 BA^2 \gamma p} \cdot \frac{h^3 d^2}{a^6},$$

where $\gamma$ = sp. gr. of oil, $p$ = effective length of channel, $h$ = thickness of membrane, $d$ = diameter of opening of mirror tube, $a$ = diameter of the membrane and A and B are two constants. For a seismograph fitted with a brass diaphragm, the data were $h = 0 \cdot 021$ cm., $d = 1 \cdot 9$ cm., $\gamma = 0 \cdot 95$, $A = 0 \cdot 36$, $B = 8 \cdot 77 \times 10^{-14}$ $p, = 2 \times 1 \cdot 75 \times 2 \cdot 54$ cm. The period comes out to be $2 \cdot 02$ secs. This is very nearly the observed period.

The above form of the vertical or horizontal component seismograph is clearly defective. For, there is a limit to the mass which can be suspended from or fixed to the centre of the membrane and this 'mass' is comparable to the weight of the liquid which rests on the membrane. It does not therefore act as a free mass. A "mass" which would remain stationary when an impulse is communicated to the instrument would require to be considerably greater than the weight of the oil. Without a suitable stationary mass, the differential motion (*i.e.*, motion with respect to the stationary mass) communicated to the membrane by ground movement is very small.

In the later models, therefore, the design of the vertical component seismograph was modified to that shown in Fig. 3. In this form the whole instrument, which is suspended from a rigid support by means of a rod attached to the centre of the membrane, AC, acts as a stationary mass. If the support moves vertically downwards or upwards through a distance $\delta x$, the centre of the membrane moves through a distance $\delta x$ and thus forces out or draws in the oil through the tube. In practice this form of the instrument was also found not to work very satisfactorily. This was due to the membrane being strained and assuming a conical shape under the weight which it had to support.

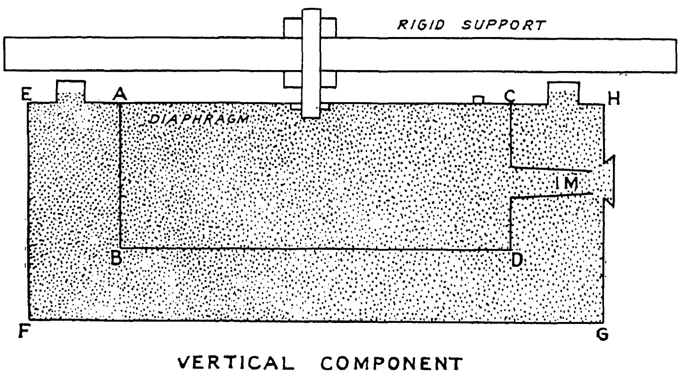



Fig. 3.

To remedy the above defect the instruments were modified to the forms shown in Figs. 4 and 5. The horizontal component is suspended by a bi-filar string from the roof of the building so that the plane of oscillation is in the direction in which the horizontal component is to be recorded. It is found that the best sensitiveness is obtained when the length of the string is such as to give a period equal to the free period

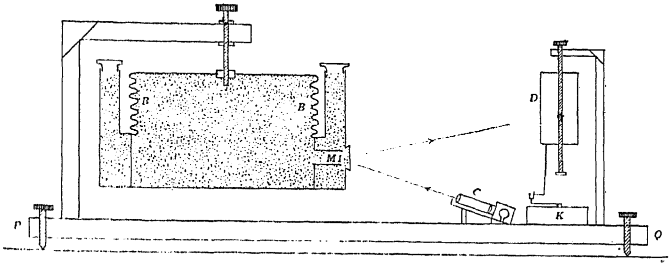



**Fig. 4.**

Vertical Component.

BB—Flexible Bellows. M—Mirror. C—Collimator Telescope. D—Recording Cylinder. K—Driving Clock. PQ—Cast Iron Stand.

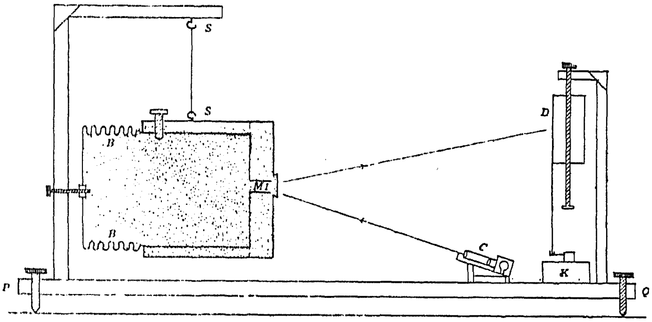



**Fig. 5.**

Horizontal Component.

BB Flexible Bellows. M—Mirror. C—Collimator Telescope. SS—Suspension Wire. D—Recording Cylinder. K—Driving Clock. PQ—Cast Iron Stand.

of the membrane. In these instruments the membranes used have cylindrical forms and consequently they undergo no abnormal deformation and retain their elastic afterworking. The most suitable form of membrane for instruments of this type appears to be the flexible bellows (cylindrical), now manufactured on a commercial scale. The preliminary observations made with these modified instruments indicate that they are more sensitive to earthquake movements than the earlier forms.

Fig. 6 is the record of an earthquake and Fig. 7 of microseisms obtained with vertical component hydraulic seismograph.

The chief advantage of an instrument of this type lies in the fact that the parts are all assembled and it can be carried from one place to another and installed in working condition in a short time. Even the most violent movements of the ground cannot displace any of the working parts. The damping ratio can be increased to any desired extent by making the tube in which the mirror is suspended tapering. The calibration of the displacement of the speck of light on the photographic paper in terms of the actual ground movements is readily made by arranging to give specified motions to the platform on which the instrument rests.

The chief defect of the instrument lies in its susceptibility to pressure fluctuation produced by gusts of wind. This effect arises on account of its functioning more or less like an aneroid box. It has been considerably reduced in the latest form of the instrument by making the box (including the oil) as heavy as possible consistent with the elasticity of the membrane, so that the variation in pressure fluctuation becomes negligible compared with the total weight which the membrane has to support. Nevertheless the effect is there and becomes conspicuous when a large magnification is adopted. The effect can be further reduced by installing the instrument in a

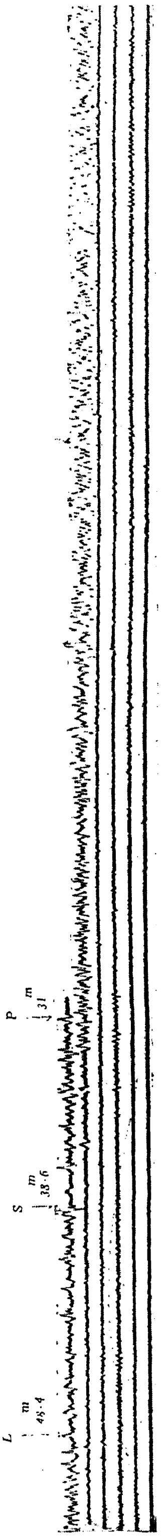



Fig. 6.

Record of an Earthquake by Hydraulic Seismograph (Vertical Component). Distance of Earthquake, 3,600 miles. The interval between consecutive breaks equals one minute of time.

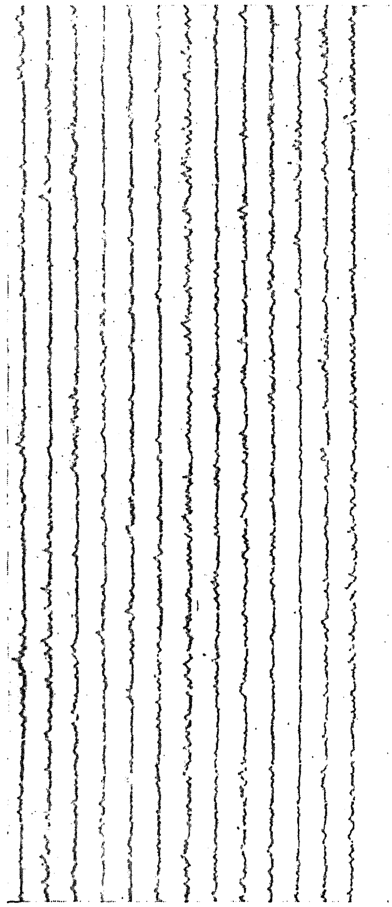


Fig. 7.

Record of microseisms by Hydraulic Seismograph, Vertical Component. (The interval between consecutive breaks equals one minute of time.)

double-walled room with an air-gap in between which acts as a damper to pressure fluctuations.

The instruments are still in an experimental stage and it is hoped to introduce further improvements in them.

My thanks are due to Mr. K. N. Sohoni who assisted me in taking the earlier series of observations.

# Winters in the Punjab.

By J. B. Seth, M.A. (Cantab.), I.E.S.,
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I WAS much interested to read the two articles in *Current Science* of February, 1935, on the recent cold waves by Drs. Ramdas and Roy of the Indian Meteorological Department. The cold wave of January, 1935, was undoubtedly much longer and, judged by the minimum shade temperatures (of air), much severer than that of 1929. Thus according to the tables given in Dr. Roy's paper, the 1929 cold wave lasted only 5 days while this year's lasted 9 days. Moreover, the air temperatures registered this year were decidedly lower than those in 1929.

I am writing this to bring it to the notice of those interested that the length and severity of a cold wave as judged by air temperatures do not seem to have much correlation with ground frosts, at least so far as the Punjab is concerned, if one may generalise from the weather data about Lahore which alone are available to me. Dr. Roy implies in his paper, and one would certainly be inclined to think, that since the minimum air temperatures registered in 1935 were much lower and for a much longer period than those registered in 1929, the ground temperatures in the current year would also have been lower than those in 1929. The state of affairs, however, at least so far as Lahore is concerned, is, strangely enough, just the opposite.

During the cold wave of this year the lowest temperature on grass registered in the local meteorological observatory was 19°·0 F. on the 18th January on which day the minimum shade temperature of air was also the lowest recorded during the cold wave, namely, 27°·8 F., which is, incidentally, the lowest air temperature ever recorded in Lahore since January 1879—data for years previous to this are not available in the local meteorological observatory. The lowest temperature on grass registered in 1929 was more than 4 degrees lower than that registered this year, namely, 14°·7 on the 31st January, 1929, on which date was also reached the lowest of air temperatures for that year's cold wave at 29°·0 F.

During the cold wave of this year the minimum air temperature in Lahore continued to remain below or at the freezing point for 7 mornings (13th to 19th January); during 1929 the corresponding number was only three (31st January—2nd February). But this year ground frosts took place, besides, of course, the frosts of the seven mornings of the cold wave, only one day before and one day after the cold spell: on the 11th January the grass minimum was 37·0, from the 12th to 20th it remained below the freezing point but then it shot up from 28·0 on the 20th to 43·2 on the 21st morning, due of course to the incidence of cloudy weather; and it never went below freezing after the 20th January though it once again touched 32·0 on the 27th January. It may also be mentioned at this stage that before the incidence of the cold wave of this year there had been two to three degrees of ground frost for seven mornings from the 3rd to 9th January and that altogether during the 1934-35 winter there had been, before the incidence of the cold wave on the 12th January, 16 frosty mornings, the first frost of the season having been registered on the 26th November, 1934, when the minimum grass temperature went down to 28°·9 F. The minimum grass temperature of the 20th November had only just touched the freezing point, having been 31°·9 F. Thus the total number of mornings during the 1934-35 winter when the minimum grass temperature reached or went below 32°F. was 27 including the days of the cold wave.

The winter of 1928-29 in Lahore was much severer than this year's judging from ground frosts. Thus the frosts during the mornings of the cold wave of that year had been preceded as well as followed by three successive mornings. During the days when the cold wave was actually passing through Lahore, the grass minimum temperatures were 14·7, 16·9 and 15·2 on the 31st January, 1st and 2nd February, 1929, respectively. These were followed altogether by 14 more frosty mornings upto the 19th February and had been preceded by a very large number of similar mornings. Thus between the 5th December, 1928, when the first frost of the season was registered, the grass minimum being 29·0, to the 30th January, 1929, the eve of the incidence of the cold wave and on which morning 25·4 was reached on grass, there had been 38 mornings on which the

minimum grass temperature went down to or below the freezing point. Altogether during 1928-29, the number of such mornings was 58, the first being the aforesaid 5-12-1928 and the last, 4-3-1929 with 29°·1 F.

It should be mentioned here that in 1929 the minimum grass temperatures were registered by a thermometer the bulb of which was kept in contact with a woollen pad laid on the ground. Since October 1933, however, the grass temperatures are being registered by a thermometer kept about an inch above the ground level on wooden cross supports. The so-called grass temperatures observed according to the latter, *i.e.*, the current practice will probably be a little higher than if the older method were used. But all the same, residents of Lahore will have no doubt about the frosts of January-February 1929 having been much severer than those of January, 1935.

It is interesting to note that January of this year (1935) had been preceded by an abnormally warm December. Between the 1st December, when the grass minimum had just gone below freezing (to 31·8) to the 29th December, when it went again below freezing (to 30·2), the mean temperature of the day (the mean of the maximum and minimum air temperatures in shade) remained above the normal mean temperature almost every day, so that the average of the daily mean temperatures for the month reached 57·6, nearly two degrees above the normal monthly average (the mean of the 31 daily normal temperatures) of 55·7. January was also followed by a warm February, the monthly average having been 59·4 as against the normal average of 57·9. However, compensation for these abnormally high averages was provided by the length of the cold wave and its having been followed as well as preceded by quite cold days. This made the monthly average temperature for January abnormally low, being only 51·2 as against the normal average of 54·4. With the result that the mean temperature for the 1934–35 winter season (1st November–15th March) comes out to be 59·2, only a fifth of a degree above the normal mean for the same period.

I understand that officially the winter is regarded to last from the 15th October to 15th March. I have, however, regarded it to commence on the 1st November for the normal daily temperature of Lahore goes down below 70 (to 69·5) on the 2nd November and remains below 70 till the 16th March the normal temperature for which day is 69·6. The normal temperature of 1st November is 71·1 and of 17th March 70·6. These normal temperatures for each day of the year were supplied to the local meteorological observatory certainly more than 20 years ago and perhaps should be revised. Returning, however, to the duration of winter in Lahore, I feel it should be regarded to last only for that period during which the normal daily average does not exceed 65°F. Applying this criterion the winter in Lahore should be taken to last from 15th November (normal temperature, 64·7; the normal of 14th being 66·1) to 6th March (normal temperature 64·6; the normal of 7th being 65·7). Table I summarises the points brought out in the foregoing.

TABLE I.

(*giving a few details about the winters of 1928–29 and 1934–35 at Lahore. Temperatures are in degrees F.*)

| | 1928–29 | 1934–35 | Normal |
|---|---|---|---|
| Average temp. for Nov. | 66·0 | 64·7 | 64·5 |
| ,, ,, Dec. | 56·9 | 57·6 | 55·7 |
| ,, ,, Jan. | 54·2 | 51·2 | 54·4 |
| ,, ,, Feb. | 58·0 | 59·4 | 57·9 |
| ,, ,, March 1–15 | 69·0 | 67·6 | 66·1 |
| Average temp. from 1st Nov. to 15th March. .. | 59·6 | 59·2 | 59·0 |
| Average temp. from 15th Nov. to 6th March. .. | 57·6 | 57·1 | 57·2 |
| No. of days when grass minimum reached or went below 32°·0 .. | 58 | 27 | .. |
| No. of days when air minimum reached or went below 32°·0 .. | 3 | 7 | .. |
| Lowest minimum air temperature recorded (with date) .. .. | 29·0 (31 1) | 27·8 (18 1) | .. |
| Lowest minimum grass temperature recorded (with date) .. .. | 14·7 (31 1) | 19·0 (18 1) | .. |

I should also like to mention here that it does not seem to be very uncommon in Lahore and I suppose, therefore, in the plains of the Punjab generally, to find quite severe frosty mornings without the minimum air temperatures reaching even the freezing point. This as well as several other interesting features about Lahore winters are brought out in Table II which goes back to the wirter of 1921–22.

TABLE II

(*showing the relative severity of winters in Lahore.*)

| Season | Average temperature 1st Nov.—15th March. Normal for the period = 59·0 | No. of days when grass minimum reached or went below 30° F. | No. of days when 8 degrees or more of ground frost was registered | Average frost during the season (total of degrees of frost each day ÷ the number of mornings) | The first day when the grass minimum reached or went below 32, giving the temperature | The last day for above | Lowest grass temperature giving date | Lowest air temperature in shade giving date | Extra data about the last two columns where necessary. g = grass min. a = air min. |
|---|---|---|---|---|---|---|---|---|---|
| 1921–22 | 61·3 | 21 | 0 | 2 | 10/12(30·5) | 7/3(31·8) | 27·0(22/1) | 37·4(4/1) | g 27·8 on 4/1; a 38·6(22/1). |
| 1922–23 | 59·3 | 24 | 2 | 3 | 17/11(31·3) | 10/2(31·2) | 21·8(2/1) | 35·4(2/1) | |
| 1923–24 | 59·4 | 39 | 8 | 4 | 15/11(31·9) | 19/2(30·9) | 23·0(31/12) | 35·6(31/12) | |
| 1924–25 | 58·5 | 63 | 17 | 5 | 20/11(29·9) | 2/3(31·2) | 19·9(24/2) | 34·7(15/1) | g 21·0(15/1); a 37·4(24/2). |
| 1925–26 | 58·9 | 59 | 16 | 5 | 21/11(31·2) | 21/2(32·1) | 20·9(21/12) | 35·3(21/12) | |
| 1926–27 | 58·4 | 81 | 36 | 7 | 16/11(30·0) | 8/3(27·2) | 15·3(11/1) | 32·0(11/1) | |
| 1927–28 | 61·4 | 26 | 1 | 3 | 23/11(30·3) | 18/1(31·7) | 23·4(17/12) | 37·9(17/12) | |
| 1928–29 | 59·6 | 58 | 12 | 5 | 5/12(29·0) | 4/3(29·1) | 14·7(31/1) | 29·0(31/1) | |
| 1929–30 | 59·2 | 52 | 13 | 5 | 6/11(30·2) | 4/3(31·4) | 20·0(7/1) | 34·1(19/1) | g 21·3(19/1); a 34·9(7/1). |
| 1930–31 | 58·4 | 50 | 14 | 6 | 8/12(24·9) | 23/2(27·2) | 17·0(25/12) | 31·8(23/12) | g 17·3(23/12); a 37·2(25/12). |
| 1931–32 | 60·6 | 19 | 0 | 2 | 16/12(31·4) | 17/2(32·0) | 26·2(30/12) | 33·6(30/12) | |
| 1932–33 | 58·7 | 32 | 8 | 5 | 8/12(32·0) | 30/1(29·8) | 20·0(7/1) | 30·0(14/1) | g 24·2(14/1); a 31·3(7/1). |
| 1933-34 | 59·9 | 34 | 14 | 6 | 14/12(31·0) | 8/2(31·0) | 20·0(2/2) | 30·3(20/1) | g 20.9(20/1); a 32.3(2/2). |
| 1934–35 | 59·2 | 27 | 7 | 5 | 20/11(31·9) | 27/1(32·0) | 19·0(18/1) | 27·8(18/1) | |

The different data incorporated in this communication will probably remain incomplete if I do not also give a list of all those days in Lahore since 1st January 1879, on which the minimum shade temperature of air went below 30° F. There have not been very many such days during the last half century (to be accurate the last 57 years) and these are set down in Table III.

TABLE III

(*showing the days in Lahore since* 1879 *when the minimum air temperatures went below* 30° *F.*)

| Year | Date | Minimum Air Temperature | Grass minimum on the same day |
|---|---|---|---|
| 1889 | Jan. 19 | 29·2 | 18·8 |
| 1910 | Dec. 23 | 29·4 | 17·9 |
| 1929 | Jan. 31 | 29·0 | 14·7 |
| 1935 | Jan. 15 | 29·1 | 21·3 |
| ,, | ,, 17 | 28·1 | 20·2 |
| ,, | ,, 18 | 27·8 | 19·0 |
| ,, | ,, 19 | 28·3 | 20.2 |

A study of the data included in this paper leads one to the conclusion that very low air temperatures are not of too common occurrence in the plains of the Punjab whereas quite low ground temperatures are not so uncommon. Really low temperatures seem to result only from actual cold waves; severe ground frosts, on the other hand, do not necessarily mean the incidence or passage of a cold wave.

Low ground temperatures would result from the combined influence of an extremely clear sky and an almost total absence of water vapour in the atmosphere. If the water vapour present is not negligible the ground temperatures may not reach very low figures even though there be a clear sky and, due to a cold wave, below freezing air temperatures. This was perhaps what happened during the last cold wave. On the other hand, absence of any air currents near the ground may be responsible for very low ground temperatures not being accompanied by low air temperatures, there being a difference in level of about 4 feet between the thermometers registering air and grass temperatures.

Another remarkable fact stands out from Table III. During the 50 years preceding

1928, air temperatures (in shade) went below 30° F. only on two occasions, once in 1889 and once again in 1910; whereas during the seven years that have followed 1928, there have been two cold waves resulting in lower than 30° temperatures on one day in 1929 and four days in 1935. One must not really generalise from such meagre premises but it would appear as though we were in for a period of more frequent cold waves!

In the end I must thank the Indian Meteorological Department for giving genera permission, several years ago, to their office in-charge of the local observatory to allo me access to the records, etc., kept in Lahor And I cannot close without also thankin the local officer, Mr. Dina Nath Chop without whose active help and co-operatio I would not have been able to maintain m interest in matters meteorological, nor ab to give all the facts and figures incorporate herein.

## Stigmas and Awns—Their Homology.

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and
V. Panduranga Rao, M.A.,
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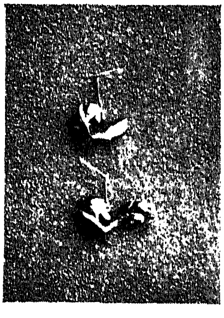
THE existence in certain varieties of sorghum of fertile pedicelled spikelets has been noted (G. N. Rangaswami Ayyangar, and V. P. Rao, 1935).[1] One of these varieties, M. S. 1644, is awned. It is well known that in awned varieties the sessile spikelets bear awns and the pedicelled ones do not have them. The occurrence of grain-bearing fertile pedicelled spikelets raised the question whether such fertility resulted in the stimulation and manifestation of the otherwise absent awn in the pedicelled spikelets. An examination of these fertile pedicelled spikelets showed that they did develop the awn concurrent with this fertility—only the expression of the presence of awn was a bit feeble. In Fig. 1 the top picture shows



×1

Fig. 1.

the pedicelled sterile spikelet without awn and in the bottom one the same pedicelled spikelet when it bears a grain also develo the awn. Where awns did occur, measure ments show that they were about ha the length of the normal awn: norm —6 mm.; pedicelled—2·9 mm.—(averag of 100 readings.) Pedicelled spikelet without awns have occasionally anther This activation into a manifestation of th awn concurrent with the appearance o the ovary with the stigma raised the probabl homology between awns and stigmas. Look ing up literature it was noted that Harla (1931)[2] working in Barley "had felt fo some years" that the barbs on the awn and the hairs on the stigma arise from th same basic tissue. In 1915 he notice a high positive correlation between th number of teeth on the awns and the numbe of hairs on the stigmas. The experienc recorded above in which the awn as a organ manifested itself concurrently wit the stigma, gives unmistakable proof o their inter-relationship.

Next to this concurrent presence of stigm and awns in awned varieties is the parall that exists in their general morpholog In Fig. 2. are given two stigmas (*a*) tha of *Sorghum Durra*, Stapf, the Grain Sorghum and (*b*) that of *Sorghum Nervosum*, Bes the fodder type, *Irungu Cholam*. It wi be noted that in *S. Durra*, the stigmati feathers cover half the style, and in *S Nervosum* a little less than a third. Fig. gives the photographs of the respectiv

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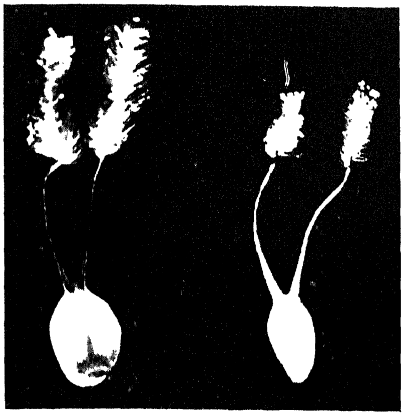
[1] *Curr. Sci.*, 1935, **3**, 433–34.

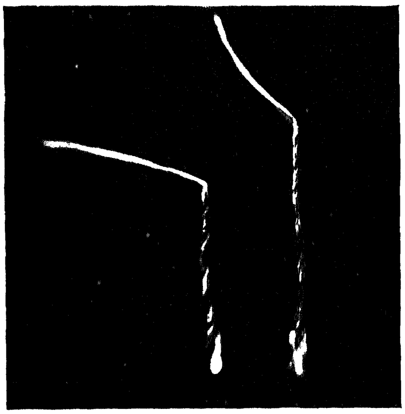
[2] *Jour. Hered.*, 1931, **22**, 271.

awns and bears out a somewhat similar distribution between the subule and the column. In Table I the relative measurements are recorded.



(a) (b) ×7·5

Fig. 2.



(a) (b) ×7·5

Fig. 3.

TABLE I.

(*Average of* 100 *readings*.)

| | (1) Length of Style m m. | (2) Length of Stigmatic Zone mm. | Ratio of (1):(2) | (1) Length of Column mm. | (2) Length of Subule mm. | Ratio of (1):(2) |
|---|---|---|---|---|---|---|
| *S. Durra* | 2·0 | 2·0 | 1 : 1 | 3·5 | 3·5 | 1 : 1 |
| *S. Nervosum* | 2·5 | 1·0 | 2·5 : 1 | 6·0 | 3·0 | 2 : 1 |

In Table II are given measurements bearing out the general parallel trend in the spindle shape of the disposition of hairs and barbs of the two organs.

TABLE II.

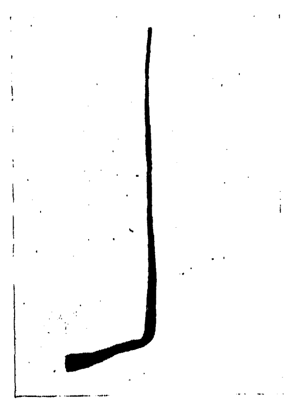
| | Length in $\mu$ | | | Average of |
|---|---|---|---|---|
| | Bottom | Middle | Top | |
| Stigmatic feathers .. | 288 | 452 | 164 | (300 readings) |
| Barbs in the subule . | 42 | 132 | 60 | ( 60 „ ) |

In Table III, the morphological variation in the longest feathers of the spindle keep parallel to the longest barbs in the awns between varieties.

TABLE III.

| | Length in $\mu$ | | | Average of |
|---|---|---|---|---|
| | *S. Durra* | *S. Nervosum* | *S. Margaritiferum* | |
| Stigmatic feathers.. | 555 | 456 | 344 | (100 readings) |
| Barbs in the subule .. | 180 | 126 | 90 | ( 60 „ ) |

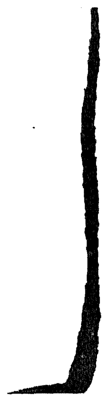
There are no smooth awned varieties in sorghum; but an African variety, A. S. 3455, manifested the rare phenomenon of irregular feathering, giving the stigmas a chequered featheriness in contrast to the usual good brush they ought to be. This variety was examined and its awn gives the nearest approach to a smooth awn that could be had in sorghum (Fig. 4). An



×7·5

Fig. 4.

enlargement of the normal awn borne on a flower with a normal stigma is given in Fig. 5 and the presence and regularity of the



×7·5

Fig. 5.

barbs in the latter will be patent. The stigmatic feathers of this variety instead of being of the bushy multicellular type of the normal stigma (Fig. 6) were a varying

×100

Fig. 6.

mixture of a few multicellular and many unicellular feathers (Fig. 7). An enlarge-

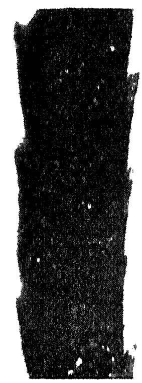
×100

Fig. 7.

ment of a purely unicellular stigma in thi variety is given in Fig. 8. In Fig. 9 i

×100

Fig. 8.



×100

Fig. 9.

given an enlargement of the barbs in t normal awn. The resemblance between t two unicellular structures is noticeable.

These parallelisms serve as evidences the homology between stigmas and awns.

Not all sorghums are awned. There a awnless races, awnlessness being domina (G. N. Rangaswami Ayyangar, 1934)[3]. The awnless varieties bear grains and ha stigmas. The homology is therefore pate only when the factors inhibiting the expre sion of awn are absent. It would therefo seem that whereas it is probable that bo the awn and the stigma may have specialis from the same basic tissue, their parallel a concurrent specialisation is conditioned the absence of factors inhibiting the expre sion of the awn. Genetic factors seem t profoundly to affect homologous expressio

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[3] *Madras Agric. Jour.*, 1934, 22, 18.

# Crab-Fishing at Uttarbhag, Lower Bengal.[1]

By Sunder Lal Hora, D.Sc., F.R.S.E., F.A.S.B.,
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SCYLLA SERRATA (Forskål) is the commonest edible crab of the deltaic Bengal. It is known as *Samudra Kekra* and large quantities of it are brought alive to the Calcutta markets where they command a ready sale, the flesh being greatly relished by the Bengalee population. The species grows to about 8 inches across the carapace and is one of the largest and strongest of the Indian crabs. *Scylla serrata* is widely distributed in the Indo-Pacific region and is abundant in estuaries, backwaters and mangrove swamps; it is also capable of living in fresh water. Stebbing[2] remarks that "On the muddy coasts of the Bay of Natal, Krauss says, this species lives in great deep holes, and wears the dingy earthly colour of its residence. They sit at the openings of their holes when the tide is coming to snap up the food which it brings them, and to sun themselves when the tide is going out. At any one's approach they vanish into their holes in a moment, or, if their escape is cut off, they raise themselves up on their hind legs, and by clashing together their powerful claws endeavour to scare away the intruder. By driving a spade into their slanting tunnels their retreat may be cut off, or they will clutch at the proffered point of a stick and may be so drawn out, but the Caffres, who consider them dainty food, capture them by spear-throwing." I have noticed also that at Uttarbhag[3] the crab is found in deep burrows along the muddy banks of the Piali Nadi and connected channels at low tides, but the methods employed for fishing it are very different from those noted by Krauss in Natal.

**Fig. 1.**

A portion of the Hooked-Stick used at Uttarbhag for pulling out *Scylla serrata* (Forskål) from its burrow. × 1/7.

**Fig. 2.**

A boy using the implement employed for pulling out *Scylla serrata* (Forskål) from its burrow at Uttarbhag.

The implement (Fig. 1) employed for pulling out crabs from their burrows consists of a blunt iron hook, lashed to a piece of split bamboo, the length of which depends upon the individual using it. When a crab

[1] Published with permission of the Director, Zoological Survey of India.

[2] Stebbing, *A History of Crustacea*, p. 69 (London, 1893).

[3] For description of Uttarbhag and physical conditions prevailing there see Hora, "Animals in Brackish Water at Uttarbagh, Lower Bengal," *Curr. Sci.*, 1933, **1**, p. 381.

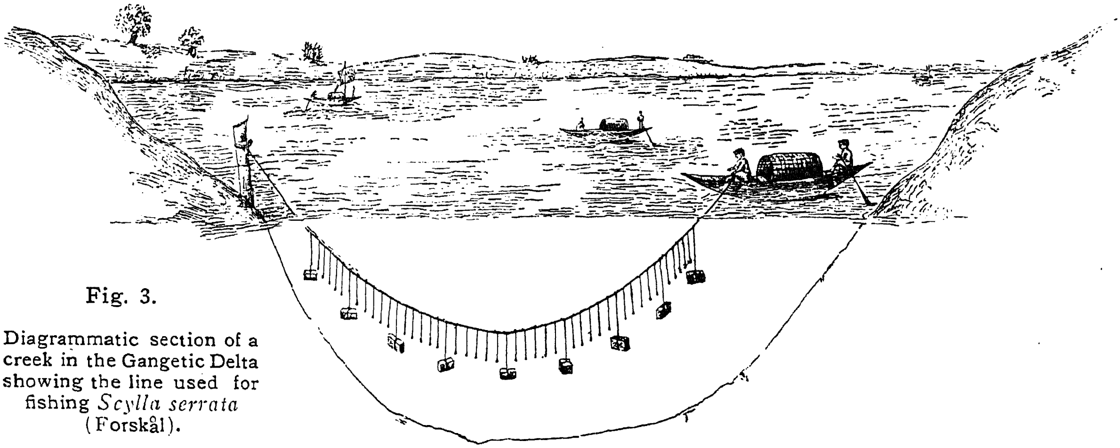

Fig. 3.

Diagrammatic section of a creek in the Gangetic Delta showing the line used for fishing *Scylla serrata* (Forskål).

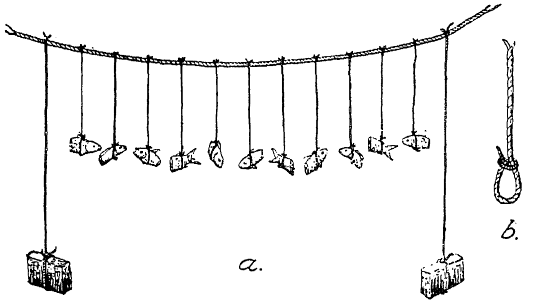


Fig. 4.

A portion of the line used for catching *Scylla serrata* (Forskål). (*a*) shows arrangement of weights and bait. (*b*) slip-noose for fastening bait.

hole is located, the hook-end is thrust into it (Fig. 2) and the rod is moved up and down or manipulated in such a way that the crab is hooked and then it is dragged out. The crab sometimes puts up a strong fight and several of its limbs are broken before it can be pulled out and secured in a basket. By this device a few crabs are collected for domestic use.

The commercial method of fishing is very ingenious. A suitable creek is selected and on one bank a thick bamboo is driven into the ground near the water level and one end of a line, which consists of about a quarter inch thick cord, is fastened to it and then the fishermen row to the other bank of the creek and go on releasing the line which is usually long enough to cover the width of the creek (Fig. 3). The other end of the line is fastened to a post in the boat. The line is weighted at regular intervals with half-bricks and in between the weights at short intervals are suspended pieces of fish which act as bait (Fig. 4*a*). Each piece is secured by a slip-noose (Fig. 4*b*) so that when the bait is pulled, the noose becomes tighter round it. Crabs are attracted to the bait and cling to the line with their strong claws. When the men in the boat feel that a sufficient weight of crabs is hanging on to the line, they begin to pull out the rope. The crabs cling to the bait with great tenacity and are transferred to the hold of the boat which is covered by planking. The weight of the rope is sometimes so

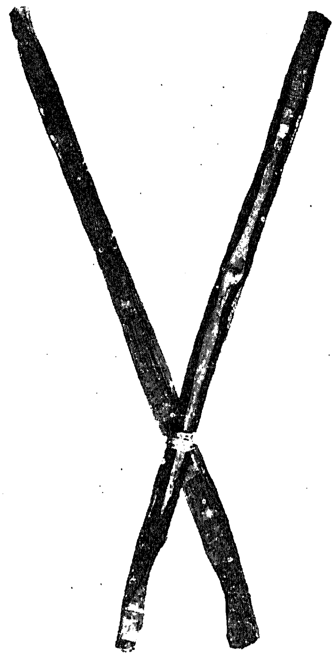

Fig. 5.

A pair of wooden pincers used for holding crabs when counting them for sale. × 1/7.

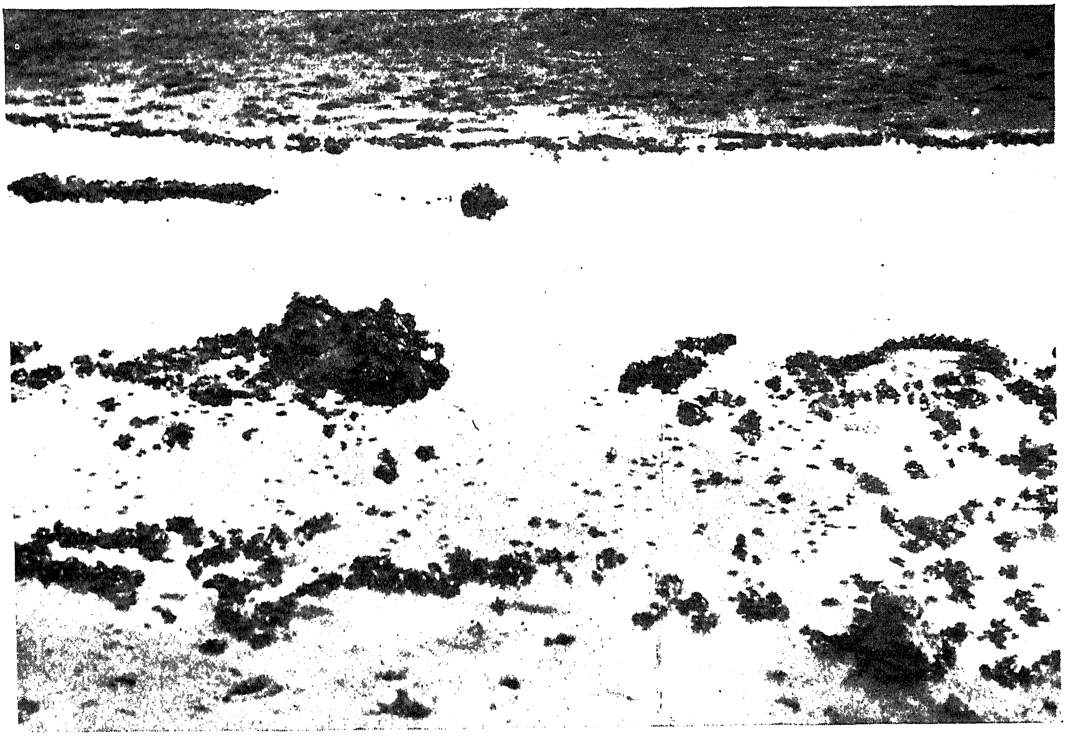

Fig. 6.

Bank of and small islands in a channel crowded with *Varuna litterata* (Fabr.). The small channel runs along the left-hand side of the road to Uttarbhag between milestones 4 and 5.

Fig. 7.

Fishing for *Varuna litterata* (Fabr.) in a small channel along the road to Uttarbhag between milestones 4 and 5.

Fig. 8.

Fishing for *Varuna litterata* (Fabr.) in a shallow, vast expanse of water at Uttarbhag. Notice several children fishing in a ring with circular nets.

heavy that 5 to 6 men are required to pull it out of the water. There is usually a small quantity of water in the hold and the crabs are kept alive in it for several days.[4]

The fishermen sell their catch to the retail vendors by quoting the price per score of individuals. The dead specimens are usually given away to poor people as they fetch very little price. In counting the crabs, a wooden pincer (Fig. 5) is used to catch each crab, as the bites of these crabs by their powerful claws are very much dreaded. These crabs are very active and the baskets containing them are securely covered.

The only other species of crab (*Chītī Kekra*) that is fished for food purpose on a small scale, but not for commercial exploitation, is *Varuna litterata* (Fabr.). It is a small species[5] rarely exceeding two inches across the carapace. It is found in great abundance and usually lives in burrows along the embankments or sides of pools. During hot months when the pools begin to dry, the crabs collect in wet places, usually in the middle of pools and are fished out by hand.[6] The real fishing season for these crabs is May-June when large numbers come together and lie along banks and in shallow waters (Fig. 6), presumably to migrate to the lower reaches of the delta for the purpose of breeding. The crabs are simply swept from such situations either with hands or with a small circular, conical net (Fig. 7). Their legs are broken and then they are stored in baskets or small earthen pots. In shallow waters the same type of circular net (Fig. 8) is used and a large number of specimens are collected. *Varuna litterata* is fished for domestic use and not brought even to the Uttarbhag market for sale.

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[4] The boats are of the same type as those used for the trade in "Live Fish"; see Hora, *Jour. As. Soc. Bengal* (N.S.), 1934, **30**, pp. 1–15, pls. i-vi.

[5] For bionomics of the species, see Hora, "A Note on Bionomics of Two Estuarine Crabs," *Proc. Zool. Soc. London,* 1933, pp. 881–884, 2 pls.

[6] Hora, "Mud-fishing in Lower Bengal," *Jour. Proc. As. Soc. Bengal* (N.S.), 1932 (1933), **28**, pp. 197–205, pls. x–xi.

# Letters to the Editor.

CONTENTS.



## Atomic Energy States of Tellurium—Te III.

IT was previously reported in *Nature*,* that the structure of the spectrum of doubly-ionised Tellurium atom had been elucidated with the help of Vacuum data kindly supplied by Dr. K. R. Rao. Further investigation of the quartz and fluorite regions with a quartz Littrow spectrograph and a Vacuum Grating Spectrograph of the branched-arm type, enabled the extension of the classification to include the higher members of the series such as the 6d, 7s, etc. More than 210 of the observed spectral lines belonging to Te III have been classified. Though there is to be observed in general, a great similarity between the term structure of Tellurium and Selenium yet the considerable complexity of Tellurium spectrum is clear in the magnitudes of the intervals of the corresponding terms. The $sp^3$ $^3P$ term-intervals in Te III, 506·7 and 1549·8 cm.$^{-1}$ for instance, are relatively very large compared to the 109 and −76 cm.$^{-1}$ of Selenium. The above is a provisional list of the terms discovered.

| Term | Term value | Term | Term value |
|---|---|---|---|
| $sp^3$ $^3D_1$ | 164069·3 | 6d $^3F_2$ | 84217·2 |
| $^3D_2$ | 153248·7 | $^3F_3$ | 83228·6 |
| $^3D_3$ | 146308·0 | $^3F_4$ | 78411·3 |
| $^1D_2$ | 146491·0 | $^1F_3$ | 78883·1 |
| $^3P_0$ | 150887·3 | $^3D_1$ | 83630·1 |
| $^3P_1$ | 150380·6 | $^3D_2$ | 74992·6 |
| $^3P_2$ | 151930·4 | $^3D_3$ | 75893·1 |
| 7s $^3P_0$ | 77058·0 | $^1D_2$ | 80343·6 |
| $^3P_1$ | 76371·6 | $^3P_0$ | 84607·6 |
| $^3P_2$ | 68544·1 | $^3P_1$ | 85762·4 |
| $^1P_1$ | 72457·5 | $^3P_2$ | 76942·8 |
| *a* | 145806·0 | $^1P_1$ | 73385·2 |
| *b* | 154654·1 | *a* | 74066·2 |
| *c* | 124833·8 | | |
| *d* | 137948·9 | | |
| 5p $^3P_0$ | 246955 | 5d $^3D_1$ | 131215·6 |
| $^3P_1$ | 242204 | $^3D_2$ | 124444·9 |
| $^3P_2$ | 238790 | $^3D_3$ | 126058·3 |
| $^1D_2$ | 229596 | $^3P_0$ | 132668·6 |
| $^1S_0$ | 215186 | $^3P_1$ | 129165·6 |
| 6s $^3P_0$ | 139492·9 | $^3P_2$ | 130243·1 |
| $^3P_1$ | 139237·3 | $^1P_1$ | 119771·4 |
| $^3P_2$ | 131539·0 | 6p $^3D_1$ | 114838·3 |
| $^1P_1$ | 132745·1 | $^3D_2$ | 114625·9 |
| 5d $^3F_2$ | 142246·2 | $^3D_3$ | 107005·3 |
| $^3F_3$ | 140649·4 | $^3P_0$ | 114692·6 |
| $^3F_4$ | 138403·9 | $^3P_1$ | 105152·0 |
| $^1F_3$ | 119713·2 | $^3P_2$ | 107290·5 |
| $^1D_2$ | 122171·7 | $^1P_1$ | 118337·1 |
| | | $^3S_1$ | 108665·3 |
| | | $^1D_2$ | 103973·1 |

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Andhra University,
Waltair,
*April* 23, 1935.

* *Nature*, August 18, 1934, **134**, 255.

## A Simple Method for Studying the Magnetic Susceptibilities of Very Small Crystals.

IN connection with some magnetic measurements on organic crystals we had occasionally to work with crystals weighing a tenth of a milligram or less. The magnetic anisotropy of these crystals is not difficult to measure.[1] For the measurement of any of the principal susceptibilities of these crystals, however, the usual methods are not applicable. The following simple arrangement, which we have been using for susceptibility measurements with such small crystals, may therefore be of interest.

Two aqueous solutions are prepared, one diamagnetic and the other paramagnetic with respect to the crystal, both having the same density as the crystal. A suitable mixture of the two solutions is kept in a thin-walled tube of about 2 mm. bore, and a few well-developed crystals are dispersed in the liquid. The tube is placed in the strongly inhomogeneous magnetic field obtaining between the usual conical pole-pieces of an electromagnet, and is adjusted so as to bring one of the crystals to a position slightly below the central axis of the field, equidistant from the two pole-pieces. Watching the crystal through a low-power microscope, and putting on the field, we find that the crystal turns round so as to place its axis of maximum susceptibility along the field, and in general moves laterally also, along the direction of the field-gradient. The relative proportions of the two solutions which make up the mixture are now adjusted such that there is no such *lateral* movement of the crystal in the field. The *maximum* susceptibility of the crystal *per unit volume* should then be the same as that of the mixture. The susceptibility of the latter is easily measured.

By changing the inhomogeneous field to a uniform one, and studying the orientations which the crystal takes up, for different initial (*i.e.*, in zero field) orientations, the directions of the principal magnetic axes of the crystal can, of course, be easily located, and the differences between the susceptibilities along these axes studied *qualitatively*.

K. S. KRISHNAN.
S. BANERJEE.

210, Bowbazar Street,
Calcutta,
*May*, 2, 1935.

[1] Krishnan and Banerjee, *Phil. Trans.* A., 1935.

## The Emission Bands of Selenium.

THE extensive emission bands of selenium have been analysed by Nevin[1] who classifies them into three systems all having the same final state X, and arising in three different excited states A, B and *b* of the $Se_2$ molecule. The last of these is involved in the well-known strong absorption system investigated by Rosen[2] and Moraczewska.[3] We have photographed these bands as produced in a discharge tube in the presence of Argon. They cover the entire region of the visible spectrum and with the exception of just a few bands which appear to be degraded towards the shorter waves, are all shaded to the longer waves. The present analysis has revealed the fact that all of these bands can be classified into one system due to the transition B→X. The $\gamma$ green-yellow bands of Nevin are part of this extensive system and therefore there is no evidence for the existence of the level A. About level *b* we are not yet quite definite but very probably the $\beta$-diffuse blue emission bands which involve this level will also find a place in the same $v'v''$ table.

Superposed on these bands is a persistent continuous spectrum which must be originating in one of the excited levels, B, C or D and the repulsive curve which arises out of the same constituent atoms that go to form the ground state of the molecule.

The states B and X are supposed to be $^3\Sigma$ levels in analogy with similar terms in $O_2$ and $S_2$. Recently, however, Olsson[4] has shown, from the rotational analysis of some of the bands which form part of the system B→X that the transition involved is $^1\Sigma_u^+ \rightarrow {}^1\Sigma_g^+$. If this is true and if the final level of these bands is also the ground state of the molecule as it appears most probable, many interesting deductions will follow.

A study of the absorption spectrum of selenium vapour is also undertaken with a view to elucidate the structure of the $Se_2$ molecule, which with the existing data of Moraczewska is not possible and a full report will be given elsewhere in due course.

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[1] *Nature*, 1930, **126**, 13.
[2] *Zeit. für. Phys.*, 1927, **43**, 69.
[3] *Zeit. für. Phys.*, 1930, **62**, 270.
[4] *Zeit. für. Phys.*, 1934, **90**, 138.

## Note on the Absorption Spectrum of some Organic Vapours.

DURING some measurements of absorption spectra in the Schumann region we have photographed also the absorption spectra of acetyl chloride, acetyl bromide, and trichloracetyl chloride down till 1510 A.U. Preliminary results have been used already in an earlier publication of this laboratory[1], but since those figures have been not very accurate, we should like to state the definite results here. The following table shows the absorption maxima of the three substances at shorter wave-length together with those in the near ultraviolet recorded previously.[1]

The first maximum, identical witn the point of predissociation known in formaldehyde and related molecules, appears in all these substances. The two chlorides show two more maxima each at shorter wave-length, but in acetyl bromide we have not been able to trace corresponding maxima.

The difference between the two first maxima agrees well with similar differences found by Scheibe and his co-workers[2] in the

TABLE I.

| | I Maximum | | II Maximum | | III Maximum | | $\Delta$ II—I | $\Delta$ III—II |
|---|---|---|---|---|---|---|---|---|
| | AU (air) | $cm^{-1}$ (vac) | AU | $cm^{-1}$ | AU | $cm^{-1}$ | | |
| $CH_3 \cdot CO \cdot Cl$ .. .. | 2750 | 36353 | 2305 | 43371 | 2017 | 49563 | 7018 | 6192 |
| $CH_3 \cdot CO \cdot Br$ .. . | 2500 | 39988 | .. | .. | .. | .. | .. | .. |
| $CCl_3 \cdot CO \cdot Cl$ .. .. | 2575 | 38823 | 2140 | 46714 | 1675 | 59701 | 7891 | 12987 |

case of ethers and alcohols and might be due to the excitation of the radicals $CH_3$ and $CCl_3$ respectively. The energy represented by the second maximum appears not to be sufficient to account for the rupture of the double bond of the carbonyl radical. The large difference between acetylchloride and trichloracetyl chloride seems to exclude a photo-dissociation in which the bonds of the radical and the chloride atom are fissured simultaneously. Therefore this energy difference represents probably an other excitation of one of the radicals; the experimental data are, however, not yet sufficient to decide these questions.

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*May* 8, 1935.

[1] *Ind. Jour. Phys.*, 1934, **8**, 537.
[2] *Z. phys. Chem.* (B), 1933, 20, 283; 1934, 25, 52.

## On the Linkage of HCl.

WITH respect to the discussion[1] in *Current Science* on the continuous absorption spectrum and the nature of the linkage in molecules like HCl, HI, etc., I should like to draw attention to the fact, that also other properties of these molecules have to be considered, since the continuous absorption spectrum is by no means a rigorously valid criterion of ionic linkage. It will be sufficient to mention only two such properties here :—

(i) HCl and HI are not conductors of electricity in the liquid state in the complete absence of water. We can easily conceive that a molecule (AgCl is an example) possesses covalent linkage in the vapour state and electro-valent linkage in solution or the molten state. The converse behaviour, however, would be very difficult to understand.

(ii) According to the wave-mechanical theory of the Raman effect, worked out by Placzek[2] on the basis of the polarisability of the molecule, a molecule with a single electrovalent bond is not able to show the Raman effect. The molecules HCl, HBr and HI show the Raman effect not only in the liquid state and even in solution in some solvents without dipolmoment, but also in the vapour state. Hence they are covalently linked in the gaseous state, and this agrees with Franck's original conclusion derived from their absorption spectrum.

As to Franck's criterion of the ionic linkage, *i.e.*, the dissociation of the excited term into normal atoms, it has been pointed out by him several times[3] that it cannot be

rigorously valid since we know that intersections of the U/r curves of the electronic terms of a covalent molecule among themselves are quite possible. If two such terms, *i.e.*, an attractive and a repulsive one, originate from the same level of the separated atoms, this is equivalent to an intersection for the purpose of the application of Franck's criterion, since it represents an intersection at very large internuclear distance.

To my mind particularly the existence of the Raman effect appears to be decisive and I have therefore treated these molecules as covalently bound in the vapour state in my "Report on Absorption Spectra and Chemical Linkage" contributed to the "Symposium on Molecular Spectra" of the Indian Academy in August 1934, which has just been published and where a discussion of the experimental detail of absorption spectra can be found. There seems to be little doubt that the shift of the red wave limit is due to a different distribution of the molecules among the vibrational levels of the ground term, which is indeed a very common phenomenon. Similar remarks apply to the molecule N≡N=O of which we know not only the Raman effect, but also the dipolmoment, Kerr constant, etc.

Department of Physics, R. SAMUEL.
Muslim University,
Aligarh,
*May* 8, 1935.

[1] S. Dutta and B. Chakrobarty, *Curr. Sci.*, 1934, **3**, 349, 478; A. K. Dutta, *Ibid.*, 1934, **3**, 477.

[2] *Z. f. Phys.*, 1931, **70**, 84; *Handb. d. Radl.*, VI.

[3] J. Franck, *Nature*, 1931, **127**, 19; Franck and Kuhn, *Bull. Ac. Sci.* (Allahabad), 1932, **2**, 223.

## On the Ratio of the Temperature Coefficients of Surface Tension and Thermal Expansion.

IN a letter to the Editor of *Current Science* (published in the March 1935 issue, p. 418), Sibaiya shows that the observed constancy of the above ratio can be deduced from Laplace's theory of Capillarity. It is interesting to note that on the experimental side, the constancy follows at once from the observed validity of the parachor law. For we have,

$$\gamma = \frac{P^4}{V^4} \qquad \ldots \qquad \ldots \quad (1)$$

$$\text{whence} \quad \frac{\frac{1}{\gamma}\frac{d\gamma}{dT}}{-\frac{1}{V}\frac{dV}{dT}} = 4 \qquad \ldots \qquad \ldots \quad (2)$$

Both (1) and (2) follow from a modification of Edser's theory of liquids which has recently been discussed by the author in a number of papers.[1] For on this theory we have

$$\gamma = \frac{\pi\mu}{4(m-5)\sigma^{m+1}} \qquad \ldots \quad (3)$$

where $\mu$ is the coefficient of the attractive force between the molecules, $m$ is the force index, and $\sigma$ is the average diameter of the spherical space kept clear around a molecule by its thermal movements at T. The close-packing equation

$$N\sigma^3 = V\sqrt{2} \quad \ldots \qquad \ldots \quad (4)$$

when combined with (3) gives

$$\gamma = \frac{K}{V^{\frac{m+1}{3}}} \qquad \ldots \quad (5)$$

where K is a constant.

Hence

$$\frac{\frac{1}{\gamma}\frac{d\gamma}{dT}}{-\frac{1}{V}\frac{dV}{dT}} = \frac{m+1}{3} \qquad \ldots \quad (6)$$

(5) and (6) reduce to (1) and (2) if $m$ is put equal to 11.

As shown in Table IV[2] the observed value of the left hand side of (2) for normal liquids is 3·4—4·2 rather than 2—3 as stated by Willows and Hatschek.[3] The wide validity of the parachor law confirms the approximate value 4.

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*April* 2, 1935.

[1] *Ind. Jour. Phys.*, 1934, **8**, 530.

[2] *Ind. Jour. Phys.*, *loc. cit.*, 535.

[3] *Surface Tension and Surface Energy*, 1915, p. 7.

THE ratio of the temperature coefficients of surface tension and density as derived from the parachor law is 4. Wheeler has shown[1] that the experimentally observed ratio for some organic liquids lies between 3·44 and 4·16, giving for the force index $m$ a value either 9, 10 or 11. Laplace's theory gives for the ratio a value equal to 2; and under special assumptions the ratio becomes 2 $(1+\epsilon)$. If the parachor value is to be accepted we have to assume that $\epsilon = 1$. Most organic liquids and liquefied gases give a value for the ratio ranging between

3 and 5; an additional list of substances with the calculated values of this ratio from the data given in International Critical Tables is given below:

| Substance | $\dfrac{\frac{1}{T}\frac{dT}{d\theta}}{\frac{1}{\sigma}\frac{d\sigma}{d\theta}}$ |
|---|---|
| $C_2Cl_4$ | 3·162 |
| $C_2H_6O$ | 3·319 |
| $C_6H_6O$ | 3·360 |
| $C_6H_5NO_2$ | 3·007 |
| $C_7H_5N$ | 3·298 |
| $\alpha$–$C_{13}H_{10}O$ | 3·256 |
| $C_6H_{12}$ | 5·340 |
| A (liquid) | 4·236 |
| $Cl_2$ (liquid) | 4·153 |
| $N_2$ (liquid) | 3·458 |
| $O_2$ (liquid) | 3·482 |
| $H_2$ (liquid) | 4·671 |
| Br | 3·343 |
| Hg | 2·290 |
| $H_2O$ | 13·2 |
| $H_2O_2$ | 2·473 |
| Pb (liquid) | 1·055 |
| Bi (liquid) | 1·491 |
| Sn (liquid) | 0·325 |

In the above table, there are, however, liquids for which the ratio is considerably different from the value 4 derived from the parachor law. The degree of approach of the experimental ratio to the theoretical value 4 for any liquid can be taken as a test of the liquid obeying the parachor law. Judged from this standpoint, liquid metals, $C_6H_{12}$, $H_2O_2$, $H_2O$, Hg, and $H_2$ (liquid) do not appear to behave like normal liquids.

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Central College,
Bangalore,
*April* 10, 1935.

[1] *Ind. Jour. Phys.*, 1931, **8**, 535.

## The Effect of Magnetic Field on Electrolytic Conductors.

IN January 1934 I observed that the conductivity of aqueous solutions of copper sulphate, potassium permanganate and others, measured by the usual Wheatstone's Bridge method using alternating current of frequency ranging from 300 to 3,000 alternations per second, did not show any perceptible change even in powerful magnetic fields; but when direct current was used, the electrolytic current flowing through the solution only for less than a second (before the commencement of the evolution of gas bubbles at the electrodes) as measured by a milliammeter, did show a definite decrease when the magnetic field was applied at right angles to the lines of flow of the electric current.

While continuing the investigation of this magnetic effect with a view to find out the exact cause of the change in conduction, another interesting phenomenon was observed, *viz.*, the deflection of streams of fine gas bubbles evolved during the electrolysis of aqueous solutions of several acids, alkalies and salts under the influence of a magnetic field.[1] While continuing and extending those investigations I have obtained the following results:—

(i) The deflection of streams of gas bubbles evolved during electrolysis or in chemical reactions (*e.g.*, action of acids on metals like Fe, Zn, Mg, and of water on calcium) and also of fine streams of solutions of electrolytes or colloids is observed only when both the electric and magnetic fields are acting simultaneously and not separately.

(ii) The same stream of gas bubbles or of electrolytic solution is deflected in opposite directions when brought near the cathode and then near the anode.

(iii) The deflection does not depend upon the chemical nature of the gas forming the bubbles or on the nature of the charged ions contained in those gas bubbles or on the charge at the interface between the gas bubbles and the solution, but it depends on the direction of flow of the current through the electrolyte and the direction of the magnetic field.

(iv) The streams of gas bubbles, etc., are mechanically deflected by the conducting electrolytic solution, which suffers deflection in opposite directions near the anode and the cathode, when placed in the magnetic field. In fact, this deflection of the solution near the electrodes can be rendered visible by suspending in it fine particles which show a rotatory motion in a clockwise and anti-clockwise directions near the two electrodes, when the solution is electrolysed in a magnetic field.

The last observation explains the results obtained by Dr. D. Nider[2] and also the

phenomenon described above, *viz.*, the decrease in electrolytic conduction in magnetic fields.

A detailed account of this investigation will be published shortly.

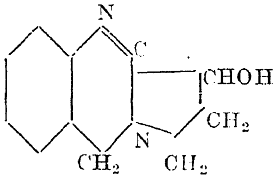
K. KRISHNAMURTI.

Chemistry Department,
College of Science,
Nagpur, C.P.,
*April* 29, 1935.

[1] *Curr. Sci.*, 1934, **2**, 387.
[2] *Praktika,* 1931, **6**, 130.

## Vasicin.

IN continuation of our note on the above subject published in *Current Science*[1] we wish to state that the picronolate of the reduction product of the base II mentioned in that paper, has been found to be identical with the picronolate of reduced vasicin. Therefore the structure of vasicin is linear and is probably I



We had started on the synthesis of I by preparing $\gamma$ *o*-nitro-benzyl amino-$\alpha$-hydroxy butyric acid with the object of closing up the quinazoline ring by reduction with zinc dust and acetic acid after lactamisation but we were surprised to find that Späth, Kuffner and Platzer[2] have just effected almost an identical synthesis. In view of the position stated by us in *Current Science*[3] we thought that we shall be allowed to complete our work but obviously it is not to be.

K. S. NARANG.
J. N. RAY.

University Chemical Laboratories,
University of the Punjab,
Lahore,
*April* 29, 1935.

[1] Vol. 3, 352–353.
[2] *Ber.*, 1935, **68**, 700.
[3] *Loc. cit.*

## 2 : 4 : 5-Trimethoxy-1-allyl-benzene. Asarone (allyl).

OLEFINIC phenols and their ethers are among the commonly occurring and important compounds in the vegetable kingdom. Though asarone (2 : 4 : 5 trimethoxy-1-propenyl-benzene) has been known since 1890, its allyl isomer has not been known, attempts at its synthesis having proved unsuccessful. It is the only allyl isomer among the naturally occurring olefinic phenolic ethers that is unknown. Recently Kelkar and B. S. Rao[1] during an examination of calamus roots found that the volatile oil contained 82 per cent. of a body closely allied to asarone, further purification leading to samples with 85 per cent. The latter could not be induced to solidify, thus showing that it was different from asarone which melts at 67°C. But as it had not been obtained chemically pure no definite conclusion could be reached.

Asarone (allyl) has now been obtained pure by treatment with selenious acid which holds back the impurities and final distillation over sodium. It is converted quantitatively into asarone (propenyl, m.p. 67°C.) by fusion with caustic potash, like other allyl phenolic ethers. The properties of asarone (propenyl and allyl) are as follows :—

| | M.p. | B. P. | $d$ | $n_d^{30}$ | $(R_L)_D$ |
|---|---|---|---|---|---|
| Asarone (allyl) (from Calamus oil) | liquid | 283/685 mm. | 1·078 ($d_4^{30}$) | 1·5578 | 62·2 |
| Asarone (propenyl) | 67°·C | 296/760 mm. | 1·165 ($d_4^{20}$) | 1·5643 | 62·7 |

Its physical and chemical properties which will be described elsewhere are in agreement with its being an allyl isomer of asarone.

Indian Institute of Science,
Bangalore,
*May* 1935.

B. SANJIVA RAO.
K. S. SUBRAMANIAN.

[1] *Jour. Ind. Inst. Sci.*, 1934, **17A**, 29.

## Vitamin C Content of Some Indian Plant Materials.

In the course of a search for a suitable raw material for the preparation of ascorbic acid for the study of its action on catheptic proteases, we have examined a large number of indigenous fruits and vegetables for their content of this vitamin, using Tillmans' method of titration against 2 : 6 dichlorophenol-indophenol as modified by Harris[1] and by Emmerie and Eekelen.[2] Some of the results are given in the following table; parallel titrations against iodine are also included, the reducing power being expressed as ascorbic acid.

The experimental findings not only show the existence of strikingly rich sources of vitamin C among materials hitherto not examined, but also throw interesting light on the variations in the conditions in which it exists in plants. Thus the four materials, Nos. 2—5, in the table below give extracts which undergo oxidation very readily as do solutions of pure ascorbic acid. This tendency to rapid oxidation runs parallel with the absence of any considerable amount of other reducing material in the extracts, as shown both by the proximity of the values obtained by titration against the indicator and against iodine, as well as by the small fall in these titres after mercury treatment of the extracts. Cashew apple and Indian gooseberry, on the other hand, give extracts of considerable stability, the latter in particular retaining its titre undiminished even after a week's standing. In these materials the difference between iodine and indicator titres are appreciable, and treatment with mercury causes the removal of a large amount of reducing material. After precipitation with mercury the extracts become readily auto-oxidisable, so that it would seem that originally they contained a substance or substances protecting ascorbic acid from oxidation and precipitable by mercury salts. It was further observed that lead acetate and trichloro-acetic acid were also capable of removing the natural anti-oxidant present in these juices. The nature of these protective (and perhaps interfering) substances is still under investigation but it was thought advisable to publish this short account of the findings already made, especially in view of the announcement by Mawson[3] of the protective action of animal-tissue extracts on ascorbic acid.

TABLE I.

| | Material | mg. of ascorbic acid per gm. of fresh material | | | |
|---|---|---|---|---|---|
| | | Initial Value | | Value after mercury treatment | |
| | | Indicator | Iodine | Indicator | Iodine |
| 1 | The Indian gooseberry—*Phyllanthus emblica* Linn. .. | 4·13 | .. | 3·65 | .. |
| 2 | Drumstick—*Moringa oleifera* Lamk. Leaf .. .. | 2·16 | 2·24 | 1·92 | 1·99 |
| 3 | " " Pod .. .. | 1·91 | 2·10 | 1·91 | 2·10 |
| 4 | *Sesbania grandiflora*, pers. Leaf .. .. .. | 1·84 | 2·02 | 1·64 | 1·95 |
| 5 | Chilli—*Capsicum fruitescens*, Linn. Green .. .. | 1·0 | 1·44 | No precipitate with mercury | |
| | " " Ripe .. .. | 1·67 | 2·17 | | |
| 6 | Cashew apple—*Anacardium occidentale*, Linn. Juice (mg. per ml.) | 2·03 | 2·86 | 1·7 | 2·05 |
| 7 | Custard apple—*Anona squamosa*, Linn. .. .. | 1·03 | .. | .. | .. |
| 8 | Ber, *Zizyphus jujuba* Jus. .. .. .. .. | 0·84 | .. | .. | .. |
| 9 | Orange (Sathukudi) .. .. .. .. | 0·63 | 0·70 | .. | .. |

Another point to which attention may be drawn is that the ascorbic acid content of chilli, as well as of other fruits tried, attained a maximum at a certain stage of ripeness, the value being lower both in the unripe as well as in the over-ripe fruits.

M. DAMODARAN.
M. SRINIVASAN.

University Biochemical Laboratory,
Madras,
*May* 10, 1935.

[1] Harris and Ray, *Biochem. J.*, 1933, 27, 303; Birch, Harris and Ray, *Ibid.*, 590.

[2] Emmerie and Eekelen, *Biochem. J.*, 1934, 28, 1158.

[3] Mawson, *Biochem. J.*, 1935, 29, 569.

## The Electrical Transference of Vitamin $B_1$ in Aqueous Solution.

WE reported[1] in 1931 that vitamin $B_1$ in a concentrate, prepared from yeast, migrated to the cathode at $p$H 8·5 in an electric field. This constituted at that time the only direct evidence for the basic nature of the vitamin, which was supported by a mass of indirect evidence. This appears to be now further corroborated by chemical studies of what appears to be the pure vitamin[2].

Recently, however, Sankaran and De[3] have called into question our evidence regarding the electrical transference of vitamin $B_1$. They state that the vitamin has an iso-electric point at about $p$H 3·0. Although this was considered highly improbable for a variety of reasons, we have re-investigated this question by subjecting a very concentrated preparation of the vitamin, obtained by the fractionation of an extract of rice-polishings to electrophoresis at $p$H 8·2, essentially according to the method of Sankaran and De, and have corroborated our earlier observation made at $p$H 8·5. The vitamin migrated to the cathode as tested biologically with rats. The solution in the anode compartment was completely inactive.

The erroneous conclusions of Sankaran and De are perhaps to be ascribed either (1) to their using a suspension of the international standard—a crude "acid clay" adsorbate—for electrophoresis, or (2) to their relying on the measurement of extinction coefficients for the assay of the vitamin, without checking their results by any of the standard biological methods.

B. N. GHOSH.
B. C. GUHA.

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Calcutta,
and
Biochemical Laboratory,
Bengal Chemical and Pharmaceutical
Works, Ltd., Calcutta,
*May* 1, 1935.

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[1] Birch and Guha, *Biochem. J.*, 1931, 25, 1391.

[2] Windaus, Tschesche and Grewe, *Z. physiol. Chem.*, 1934, 204, 123.

[3] Sankaran and De, *Ind. J. Med. Res.*, 1934, 22, 215, 233.

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## Observations on the Recent Frost Damages.

COLD waves have become rather of regular occurrence since 1929, and this year (1935) the almost total loss of a promising harvest, has attracted keen attention from scientific standpoint.

Full meteorological data have been kept up at the Station since June 1932. Table I shows the occurrence of two mild cold waves during the first season.

TABLE I.

| Days | | Max. (F.) | Min. (F.) | Soil temperature at 1′ depth (F.) |
|---|---|---|---|---|
| 1932 December 25 | .. | 70° | 43° | 75° |
| 1933 January 22 | .. | 86° | 41° | 74° |
| 23 | .. | 86° | 42° | 74° |
| 26 | .. | 76° | 42° | 75° |
| 27 | .. | 78° | 43° | 74° |
| 29 | .. | 76° | 41° | 73° |

Frost for the subsequent years—1934 and 1935—became comparatively very severe and occurred during the same period, *viz.*, 13th to 21st January. The data for these years are graphically represented in Fig. 1.

Observations on the damage done to plants were made almost immediately after each spell. Thus, in addition to cotton and tobacco in 1933, potatoes, cabbage, castor and papayas also suffered to a certain extent in 1934. The intensive study of this year has yielded more exact data regarding the damage. Thus, Cotton (*Gossypium herbaceum* and varieties), *Nicotiana tabacum* (varieties), *Cajanus indicus* and Soya Beans (*Glycine hispida*) were totally destroyed. Others like *Capsicum frutescens* (varieties), *Ricinus communis* (smaller varieties), *Solanum melongena*, *Solanum tuberosum*, *Lycopersicum esculentum* suffered from 95 to 90 per cent. The rest *Saccharum officinarum*, *Brassica oleracea*, *Cuminum cyminum* were affected to varying extents from 45 to 10 per cent. Amongst the few crops that escaped any injury may be mentioned *Allium Cepa*, *Cicir arietinum*, *Linum usitatissimum*, *Triticum sativum*, *Medicago sativa* and *Fœniculum valgare*.

Amongst the orchard and garden plants that have been affected are *Ficus carica* (100 per cent.), *Carica papaya* (90 per cent.), *Mangifera indica* (10 per cent.), *Anacardium occidentale* (50 per cent.), *Musa paradisiaca* (90 per cent.), *Eranthenum bicoler* (100 per cent.), *Jasminum Sambac* (90 per cent.), *Jasminum arborescens* (90 per cent.), *Tabernæmontana coronaria* (45 per cent.), *Rosa* sps. (10 per cent.) and *Miehœlia champak* (10 per cent.).

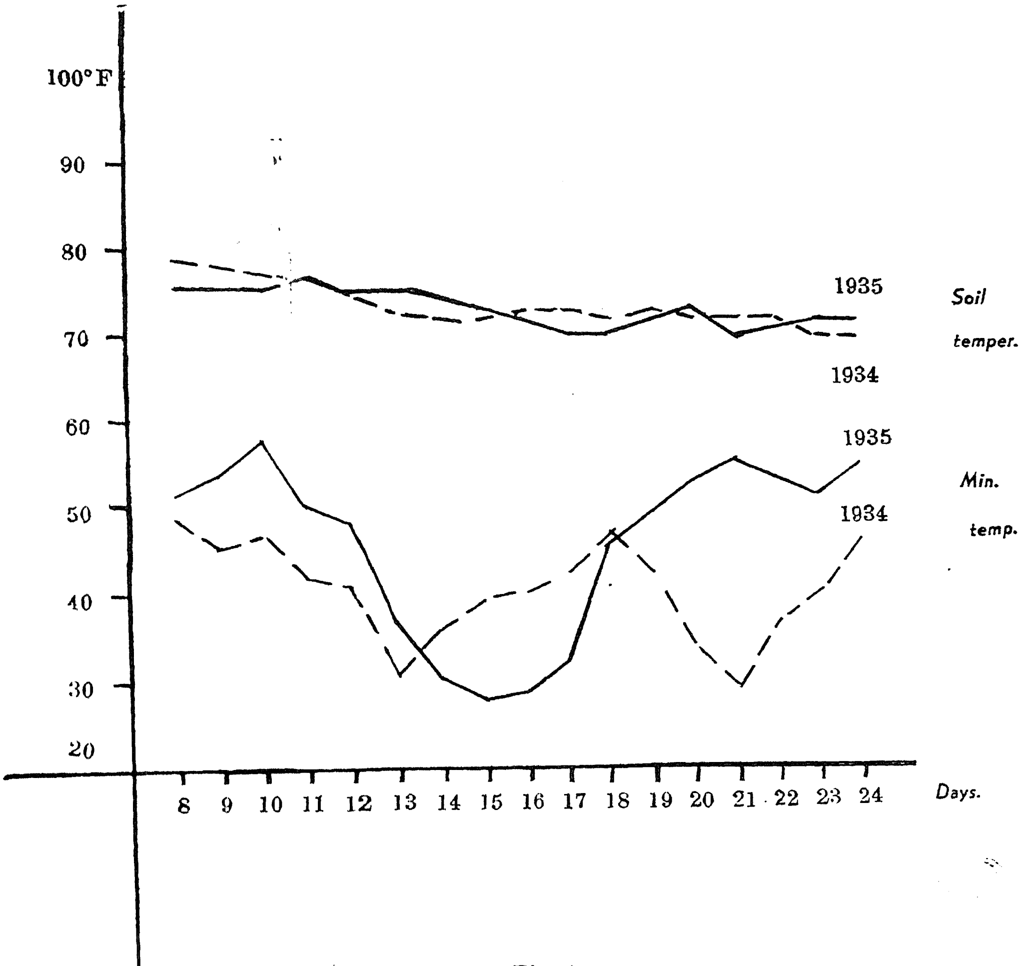


Fig. 1.

Minimum and soil temperatures for 1934-35 during the frost period.

From amongst the weeds *Crotolaria retusa*, *Mallugo hirta*, *Ocimum canum*, *Vioca auriculata* and *Trichodesma zeylanicum* suffered total destruction while the loss to *Celosia argentea*, *Leucas aspera*, *Cassia occidentalis*, *Bergia odorata*, *Cyperus rotundus* and *Phyllanthus Niruri* ranged from 10 to 90 per cent.

It may be noted that the soil temperatures up to 1 foot or below never went below 70° F. and injury had been mostly to the aerial parts of the plants. All the plants sprout fresh after the regain of the normal temperature but without any economical advantage.

F. R. BHARUCHA.
V. N. LIKHITE.
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Biological Laboratories,
Sayaji Jubilee Science Institute,
and
Research Laboratory,
Agricultural Experimental Station,
Baroda,
*February* 13, 1935.

## The Roots of *Psaronius*, Intra-Cortical or Extra-Cortical ?—A Discussion.

IN a preliminary note with the above title communicated last November to the Indian Science Congress and read before the recent Calcutta session (January 1935)[1], I wrote as follows:

" In the root-region of *Psaronius* generally two zones can be distinguished: an inner zone of relatively small roots which are very crowded and

F

sometimes flattened in consequence, with a 'packing' of thin-walled filamentous cells; and an outer zone of larger, obviously extra-cortical, free roots, which are not distorted by mutual pressure. The inner roots were formerly regarded as intra-cortical, but since 1902, after Farmer and Hill (see discussion in Scott, *Fossil Botany*, 1920, **1**, 271-275), the view has gained ground that they are also extra-cortical, the filamentous tissue being regarded as the compacted hairs derived from the roots themselves. This view was confirmed by Solms (1911)[2]" [and, I may add, accepted by the late Dr. D. H. Scott].

"After an examination of some material from Chemnitz[3] the writer has been led to believe that the intra-cortical view was after all the correct one, and that Stenzel's interpretation best meets the observed facts. Along the outer border of the inner zone the writer finds many places where there is an unmistakable compact periderm-like tissue, in places a dozen cells deep, with the cells serially arranged [see Figs. 1, 2]. This view that 'the embedding tissue is a secondary zone, developed *pari passu* with the growth of the roots after the leaves had fallen' (Scott, p. 217)."

The object of the present communication is to bring forward some further facts in support of Stenzel's view. I confess that although Stenzel's interpretation probably offers the best available solution of the problem, even this at first seemed to me rather far-fetched. I knew of no other plant, living or extinct, which showed the unusual mode of growth visualised by Stenzel; and although I have had the main facts before me for over three years, I did not feel quite convinced.

However, as stated, my preliminary note was communicated in November, and I was hoping shortly to write a fully illustrated

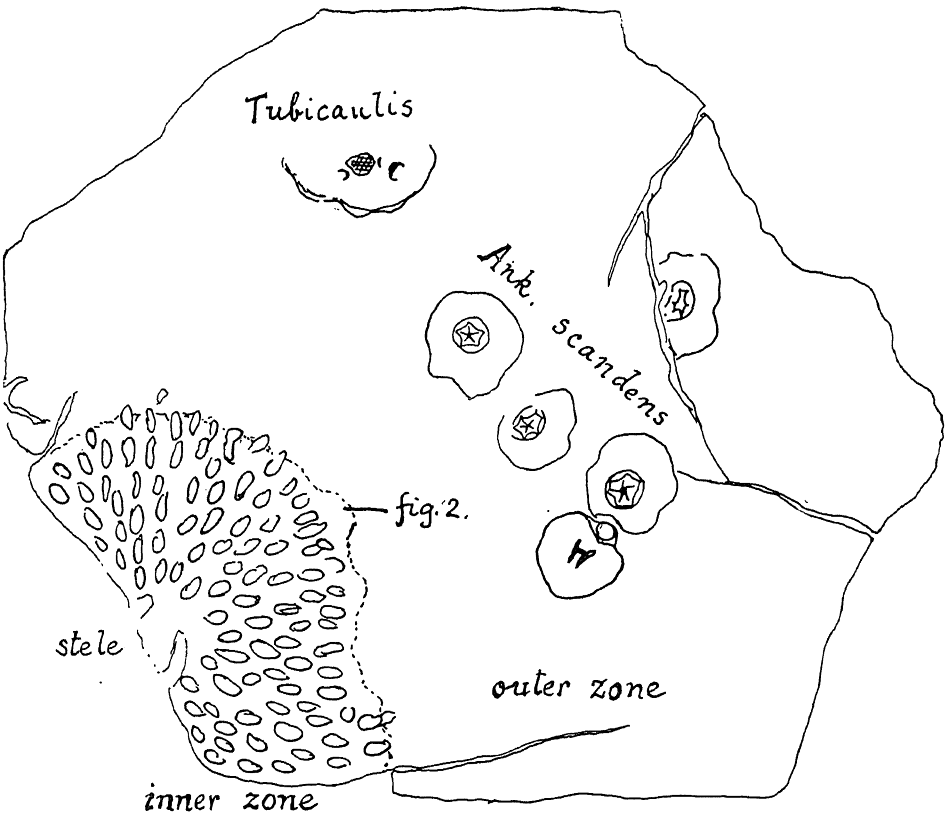



**Fig. 1.**

Outline sketch (diagrammatic) of cross-section of *Psaronius* sp., showing the position of the periderm (dotted line). Among the extra-cortical roots (outer zone) are several epiphytic stems and roots of *Ankyropteris scandens* and *Tubicaulis Berthieri*. Nat. size.

'periderm' is not in a continuous band all round but this seems to be due to the fact that here and there the inner roots are bursting out through it so as to become free."

"The absence of leaf traces among the roots cannot be questioned but is explicable on Stenzel's description of the facts, for whatever they might be worth, when indirect support for Stenzel's view came in from an entirely unexpected source, namely, a living member of the Liliaceæ, *Asphodelus tenuifolius*,

Fig. 2.

Part of the periderm, a dozen cells deep (from the same specimen). × 60.

Early in January I came to know of a paper by Mr. K. R. Mehta, M.Sc., of Benares, describing the root-system of this common weed.[4] At my request Mr. Mehta very kindly sent me a few of his original sections, which I supplemented by sections cut from plants collected in Lucknow. I was thus able to confirm his observations in the main, although the structure seems more complicated than he describes, and deserves more detailed investigation. The facts, so far as I have been able to gather them from hand-sections, are briefly as follows:

In *A. tenuifolius*, unlike the condition in most monocotyledons, there is one main root (*c.r.* in Fig. 4) which persists and behaves somewhat like the tap-root of a dicotyledon. The younger roots, whose relation to the main root still needs elucidation, grow vertically down through the cortex of the latter, rather like the intra-cortical roots of a *Lycopodium*. But they soon become so crowded that they begin to distend the main root, which meanwhile has already provided for an increase in girth through the activity of a peripheral cortical cambium (*m.p.* in Fig. 4). Thus a secondary outer cortex of thin-walled radially arranged cells (comparable to that here described in *Psaronius*) is formed. Some of the later

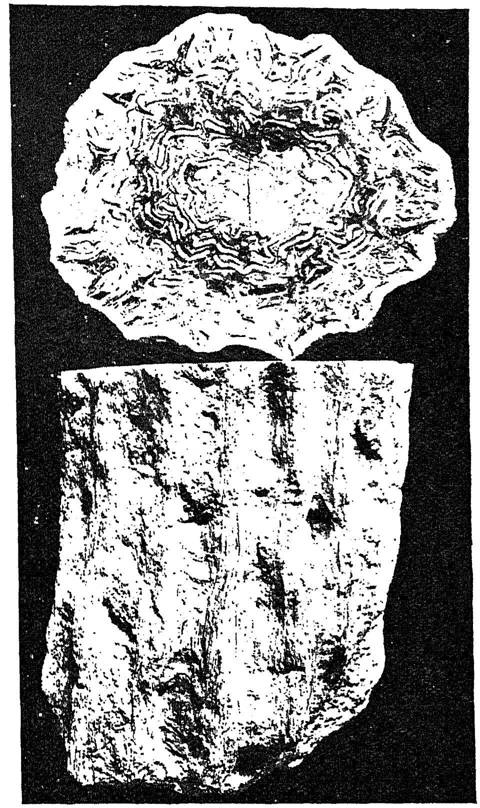


Fig. 3.

*Psaronius infarctus*: stem bereft of the intra-cortical root-zone, showing the scars of fallen leaves upon a decorticated surface in the region of the inner cortex. Photograph by A. R. Rao. ×3/10.

formed roots also contribute a little to the girth by partial periderms of their own. But it is a curious fact that *these partial periderms are developed only on their outer sides, where they are in contact with the main periderm* (*p.p.* in Fig. 4). The whole appearance strongly suggests that the formation of these partial periderms is induced by some contagious influence (? a hormone) emanating from the main periderm. The newly formed roots sometimes even grow down through the cortex of roots only slightly older than themselves (*r.r.* in Fig. 4). In a full grown plant a transverse section through the root system may show as many as a hundred or more intra-cortical roots packed round the centrally placed stele of the main root. These roots are as a rule so densely crowded that there is very little room left for any "packing tissue"; but the mode of development leaves no doubt whatever that any traces of such a tissue

that may be left can only belong to the cortex of the main root. *At the lower end of the plant the roots are seen breaking through the sheathing periderm,* either singly or in thongs of two or more, which become resolved into their constituents at still lower levels.

I ought to add here that the above interpretation has been confirmed by my colleague, Mr. A. R. Rao, who prepared at

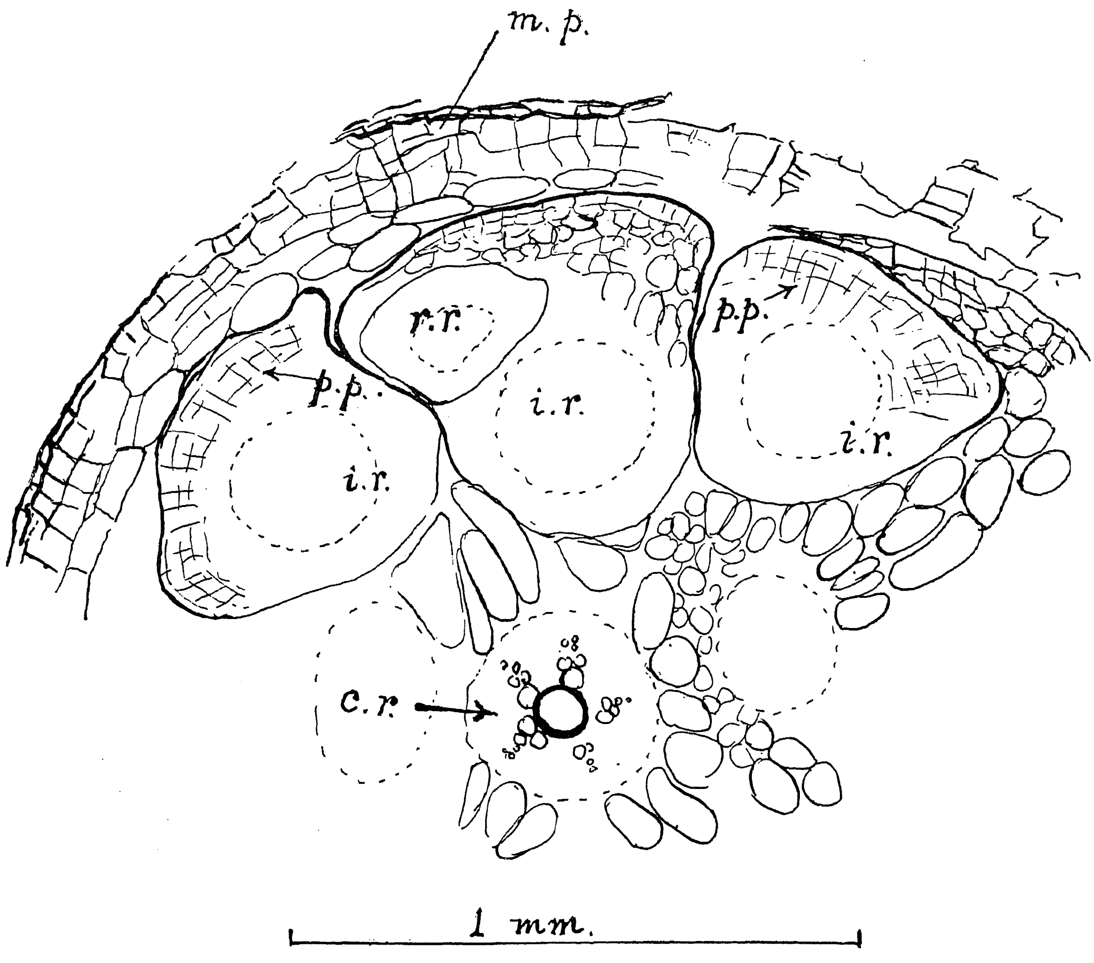



Fig. 4.

*Asphodelus tenuifolius.* Peripheral part of a transverse section of an old root, with periderms (*m.p.*), *intra-cortical roots* (*i.r.*) *with partial periderms* (*p.p.*) *on their outer sides;* (*c.r.*) central root; (*r.r.*) root within root. Camera lucida sketch from a section sent by Mr. Mehta.

my request an independent series of sections. Similarly Mr. V. Puri of Agra, who kindly undertook to prepare some further sections for me, also arrived at essentially the same interpretation.

In presenting this necessarily brief description of the root system of *Asphodelus* I do not wish to claim that we have a complete solution of the *Psaronius* problem. But the discovery of this very unusual mode of growth in a modern plant certainly provides an interesting parallel to the condition seen in the Palæozoic genus which has so long puzzled palæobotanists. Mr. Mehta does not mention *Psaronius*, but the resemblance is obvious and full of significance from our present point of view. It has, at any rate, removed my own misgivings as to the far-fetched nature of Stenzel's interpretation which, without committing myself to details, I am now prepared to endorse. I now have little doubt that the roots in question are truly intra-cortical, although the exact nature of

the packing tissue is still obscure. Considering all the facts, and especially those brought forward by Solms-Laubach in 1911 (see his Fig. 5, p. 741) it seems the packing tissue in *Psaronius* after all does belong to the roots themselves, as first suggested by Farmer and Hill; although, as Stenzel contends, it was probably of secondary origin. At this point the analogy with the partial periderms of *Asphodelus* is particularly helpful. The true explanation thus seems to lie in a combination of the views of Stenzel, Farmer and Hill, and Solms.

Stenzel's idea that the leaves had fallen *before* the root-zone was developed is also substantiated by such specimens as the one shown in Fig. 3. Here leaf-scars are visible on a surface (probably in the region of the inner cortex) exposed by the decortication of the inner root-zone; whereas leaf-scars have never been observed, so far as I know, on any surface external to the root-zone.

We thus see that the newly discovered facts strongly support the view of this acute German observer, that the compact root-zone is truly intra-cortical. For us modern workers it is well to remember that Stenzel's conclusions were based not upon an examination of thin sections but only of polished surfaces examined in reflected light.

Once more, the pioneer's work has been vindicated, although it had long been held in question.

A fuller account of the subject here discussed will be published elsewhere.

University of Lucknow, B. SAHNI.
*April* 24, 1935.

[1] *Proc. 22nd. Ind. Sci. Congress* (Botany Sec.), Calcutta, 1935.

[2] The literature is fully cited in Scott's *Studies in Fossil Botany*.

[3] Received in exchange from a private collector (Herr Guldner, a contractor of Chemnitz) during a European tour in 1930.

[4] Since published. *Jour. Ind. Bot. Soc.*, 1935, **13** (4), 271–275.

## Chromosome Numbers in some *Setaria* Species.

NAKAJIMA, GOICHI (1930)[1] records 18 as the somatic number of the chromosome in the Italian Millet, *Setaria italica*, Beauv.

At the Millets Breeding Station, the Italian Millet and some of its allies have been under study for some time. The examination of their chromosomes was taken up.

Three species of the genus *Setaria* were examined, *viz.*, (1) *S. italica* (Beauv.), (2) *S. verticillata* (Beauv.), and (3) *S. glauca* (Beauv.). *S. verticillata* is the familiar burr-like wild ally of the Italian Millet with retrorse barbs on the bristles. *S. glauca* is the *Kavutta* grass of the dry lands of Malabar and the *Korali* of the Nilgiris.

In *S. italica* whose cultivated forms show a wide range of height and vigour three types, *viz.*, (1) Dwarf, (average height 45 cm.), (2) Medium (100 cm.), and (3) Tall (130 cm.) were examined.

The young buds were fixed both in Carnoy's fluid and Allan's modification of Bouin's fluid between 9-30 and 10-30 a.m. Chromosome counts were made at diakinesis and in metaphase plates.

The haploid number of the three species have been determined as follows:—*S. italica*—9 (Fig. 1); *S. verticillata*—9 (Fig. 2); and *S. glauca*—18 (Fig. 3).[2] The three types of *S. italica* were alike.

In both *S. italica* and *S. verticillata* one pair of chromosomes was found to be much larger than the others as seen in the metaphase plates. The rest of them were more or less equal. In *S. glauca* there were two paris large and the rest equal to one another. Secondary pairing is evident in this species, showing its polyploid nature. The species is probably a tetraploid one.

The longest diameter of the nucleus (average of 20) at diakinesis of all the species

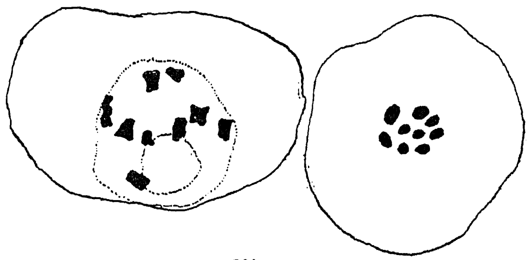


**Fig. 1.**
×1852.

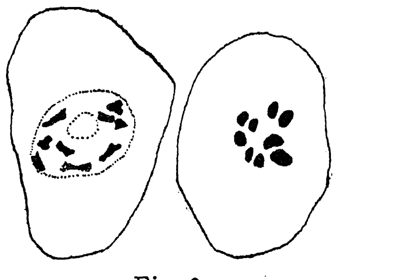


**Fig. 2.**
×1852.

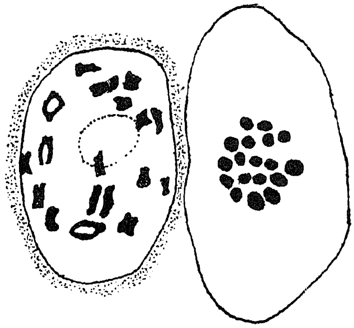


Fig. 3.
×1852.

shows that in *S. verticillata* it is small (4·85μ), *S. italica* (medium 7·45μ), and *S. glauca* (large 12·35μ).

In the classification of the *Setarias*, *S. verticillata* by virtue of its retrorse barbs and articulate fruits has been classed apart from *S. italica*, whereas *S. glauca* is ranged next to *S. italica*. It looks therefore probable that *S. italica* and *S. glauca* form the diploid and tetraploid species of one section of the genus *Setaria*.

N. KRISHNASWAMI.
G. N. RANGASWAMI AYYANGAR.

Millets Breeding Station,
Agricultural Research Institute,
Coimbatore,
*April* 11, 1935.

[1] *Herbage Abstracts*, 1931, 1, No. 1, p. 2.
[2] *Madras Agricultural Station Reports*, 1933–34, p. 442.

## Some Abnormal Ovules and Embryo-Sacs of *Thylacospermum rupifragum* Schrenk.

LAST year the writer investigated some of the developmental stages of the flower of *Thylacospermum rupifragum* along with the anatomy of its vegetative parts, a short account of which has already been published in a recent issue of this journal.[1] The entire material available in this connection consisted of about fifty fairly old flowers and a few fruits. An examination of them after sectioning yielded some interesting abnormal facts worth recording.

Ordinarily each flower of *Thylacospermum* has in its incompletely bi-locular ovary four campylotropous ovules, each with two integuments, the inner one forming the micropyle. Each of the integuments is two cells thick except for the micropylar and of the inner one which is thicker. In the centre of the ovule there is, as usual in the Caryophyllaceæ an embryo-sac, lying embedded in a thiel nucellar tissue. The fully-formed embryo sac is an 8-nucleate structure and is almos of the usual Angiospermic type except for a few differences (Fig. 1). In shape it i broad in the middle and tapers towards th two ends. The synergids are laterally hooke and are somewhat larger than the egg cell

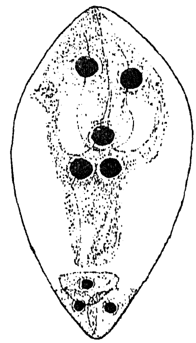


Fig. 1.

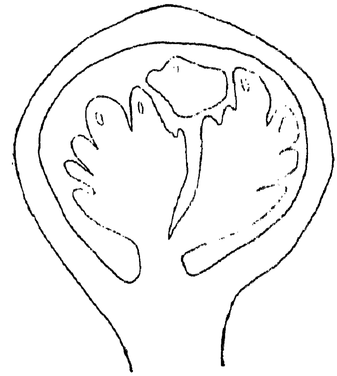


Fig. 2.

*Thylacospermum rupifragum*. 1. An 8-nucleat normal embryo-sac. ×720. 2. A l. s. (Semi-diagrammatic) of the ovary of the flower with ovules which ar lobed and contain an unusual number of embryo sacs. ×52.

The degeneration of the embryo-sac an the nucellus in the ovules seems to be o common occurrence in this plant. Most o the flowers and fruits examined showed eithe partially or completely collapsed nucellus The former was found to contain eithe degenerating embryo-sacs or empty space in their place.

One flower was observed in which th integuments and the basal part of the ovule had grown exceptionally large and as suc the ovules filled the entire cavity of the ovary The massive integuments of the ovules wer of an uneven thickness and the inner one di not form any definite micropyle as in th normal case. Mostly the top of the nucellu was left uncovered and it rested directly o the wall of the ovary. All the embryo-sac found in these ovules had degenerated.

Another interesting abnormality was me with in a flower with six ovules inside th ovary instead of the usual four. All th ovules were of a very unusual type. Eac of them was comparatively large and ver much lobed. It did not show any campylo tropous curvature. A very large vascula strand from the placenta entered the bas Each such ovule consisted of almost simil nucellar cells and did not possess any definit

integument. Fig. 2 gives a semi-diagrammatic representation of this condition as seen in a l.s. of the ovary. In each ovule one or two uppermost lobes were larger and each contained one or in some cases two embryo-sacs. On the other hand, the lobes in the lower part of the ovule were comparatively smaller and sterile. The naked condition of the ovules inside the ovary is comparable to that of the "mamelon" of the Loranthaceæ. The number of embryo-sacs per ovule varied from one to three. One of the embryo-sacs was found to be 4-nucleate and appeared normal. One 8-nucleate embryo-sac was normal, being similar to a fully-formed embryo-sac of a normal ovule. Three embryo-sacs were 18-, 16- and 4-nucleate and were of abnormal type. The exact position of the nuclei in these could not be clearly made out. Other embryo-sacs were 4-, 8-, 15- and 21-nucleate. They differed widely both from the normal embryo-sac and from one another in their size and shape and the organisation of the nuclei. A full account of them with all the diagrams will be shortly published elsewhere.

PRAKASH CHANDRA JOSHI.

Department of Botany,
University of the Panjab,
Lahore,
*April* 18, 1935.

[1] *Curr. Sci.*, 1935, **3**, 300 301.

## An Instance of Reversion of Floral Parts in *Quisqualis indica*.

WHILE casually looking at a plant of *Quisqualis indica* in the Botanical Gardens of the Benares Hindu University, in April 1934, a single large petaloid structure like the sepal of Mussænda, among an inflorescence attracted my attention. On examination, it was found that the whole of the calyx tube of a flower was modified into a single structure like the sepal of Mussænda, without any evidence of a tubular structure at all. This was arising, not from the inflorescence axis, but from the subtending bract, and with the latter, two bracts belonging to two adjacent lateral normal flowers, have also fused by their edges up to a considerable length. On the posterior surface of the single sepal was attached only one stamen with a normal anther.

As for the gynæcium of this flower, there is no trace of it, but just in the axil of this modified structure, is an organ perfectly leaf-like both as regards colour and general appearance, and is about five times the size of an ordinary bract. This structure has not got any connection with any other flower, and it may be regarded as a modification of the gynæcium.

These abnormalities may be considered as reversions to the foliar nature of the floral parts, although the cause of such a reversion cannot adequately be explained at present. The gynæcium has completely reverted to the leaf-form. The tube-like calyx of the normal flower has been modified to a large leaf-like form, but brightly coloured. This reversion itself explains the fusion of the bract with it, and points to a closer relation to a leaf, because leaves generally do not have any subtending structures.

In the specimen, the basal region of the bracts has been twisted, so that for outward appearance, the posterior side became the anterior, and *vice versa*.

V. S. RAO.

Rajahmundry,
*April* 29, 1935.

## Notes on a Collection of *Paguridea* from Porto Novo.

A COLLECTION of *Paguridea* from the backwaters of Porto Novo and its neighbourhood belongs entirely to the two families *Paguridæ*, Dana, and *Coenobitidæ*, Latreille. *Paguridæ*, Dana, is represented by the three genera, *Diogenes*, Dana, *Pagurus*, Fabricius, and *Clibanarius*, Dana, while the *Coenobitidæ*, Latreille, is represented by the single genus *Coenobita*, Latreille.

### GENUS, *Diogenes*, DANA.

The following species of the genus are included in the present collection:—

(1) *D. custos*, Fabricius. This is the most common species of the locality and a large number of them have been collected. The members of this species are found to inhabit the shells of as many as twenty-two species of gastropod molluscs.

(2) *D. diogenes*, Herbst. This is not as common as *D. custos*, Fabricius.

### GENUS, *Pagurus*, FABRICIUS.

The species belonging to this genus are comparatively rare in the locality and the genus is represented by only two species, mentioned below:—

(1) *P. hessii*,[1] Miers. This is the largest and most brightly coloured species of the collection. Only two specimens have been collected.

(2) *P. punctulatus*, Oliver. This is also large and is characteristically coloured species. Only one specimen is present in the collection.

GENUS, *Clibanarius*, DANA.

The following species of the genus have been collected :—

(1) *C. olivaceous*, Henderson.[2] This is a very common, small, backwater species of the locality.

(2) *C. longitarsis*,[3] de Haan. The species is fairly common, occurring along with *C. olivaceous*, Henderson, from which it can be easily distinguished by the presence of red and blue stripes on the legs and by the absence of any lines on the eye-stalks.

(3) *C. infraspinatus*, Hilgendorf. The species is rare in the locality and only one specimen is present in the collection. This is a fairly large, orange-yellow specimen having a carapace of 30 mm. long and is easily distinguished, by the presence of a strong, conical tubercle on the undersurface of the merus of the chelipedes.

(4) *C. arethusa*, de Man. It is fairly common in the locality.

(5) *C. aquabites*, de Haan.[4] It is not common in the locality. Only one specimen has been collected.

GENUS, *Coenobita*, LATREILLE.

The members of this genus seem to prefer heavy, gastropod shells for their abodes. It is represented by the two species specified below :—

(1) *C. cavipes*, Stimpson. Only one large specimen has been collected. It appears to be rare in the locality.

(2) *C. rugosus*, Milne Edwards. It is fairly common ; but it does not grow to a very large size. It is easily distinguished from *C. cavipes*, Stimpson, by the presence of a stridulating mechanism on the left palm.

A. RAMAKRISHNA REDDI.

Annamalai University,
Annamalainagar,
*April* 15, 1935.

[1] The key in Dr. Sundara Raj's "*Paguridea*" (*Bulletin of the Madras Government Museum*, New Series—Natural History Section, Vol. 1, No. 1, 1927, p. 131) does not include this species.

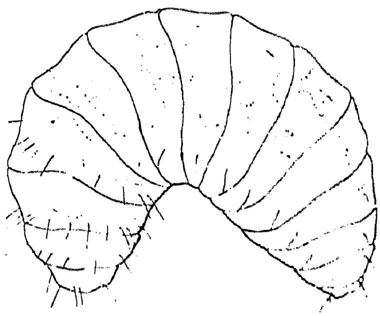
[2] The key in Colonel Alcock's "Catalogue of Pagurides in the collection of the Indian Museum" (1905, pp. 42 and 43) does not include the two common South Indian species *C. olivaceous*, Henderson, and *C. longitarsis*, de Haan.

[3] Dr. Sundara Raj (*vide Bulletin of the Madras Government Museum*, New Series—Natural History Section, Vol. 1, No. 1, p. 130) suggests that the species *C. padavensis*, de Man, which has been recorded by Dr. Henderson (*vide Transactions of the Linnæn Society*, (2) Zool. V, p. 423) from Rameswaram might quite likely be *C. longitarsis*, de Haan, since the two species at that time have not been sufficiently distinguished from each other.

[4] This species has not been recorded from Krusadai Island by Dr. Sundara Raj. It has been recorded from the back-waters of Ennur and is present both in the collection of the Madras Government Museum and in the Fisheries Bureau at Ennur.

## The Host of *Eupelmus tachardiæ*, How.

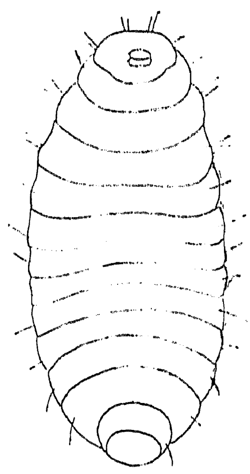
SOMEONE has said, "what I say thrice is right"; acting according to this principle Negi and Glover[1] have repeated for the third time what they asserted twice before.[2,3] While they stress the point—it is the third time their claim appears in print—, I beg equally to emphasise, thrice have they neglected to bring forth any illustrations or details with regard to the life-history of the insect or any objective information.



1 mm.

**Fig. 1.**

*Brasema annulicaudis.*



1 mm.

**Fig. 2.**

*Brasema annulicaudis.*

While dissecting the encrustation of *Lakshadia* (not *Laccifer*[1]) *mysorensis*, under a dissecting microscope I saw a larva attached to the body of an *Eublemma amabilis* caterpillar. Figs. 1 and 2 were drawn from it but remained as incomplete sketches for the larva pupated the following day, which however enabled Fig. 3 being completed.

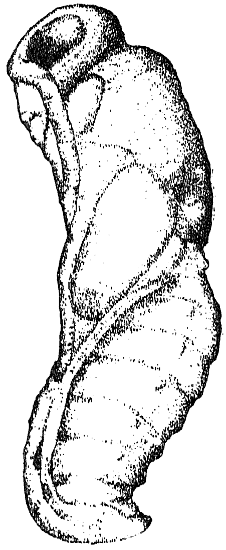



**Fig. 3.**

Pupæ of a black Chalcid *Brasema annulicaudis* ♀ Parasite on *Eublemma* caterpillar.

Since the parasitic larva and the host caterpillar were seen *in situ* there was no doubt in my mind of the former being an ectoparasite of the *Eublemma* caterpillar. The only other larva which could have been mistaken for it would have been that of *Microbracon Greeni*, Ashm. (not *M. tachardiæ*, Cam., a name used by Glover and Negi) which was excluded by my having seen its transformation into a pupa. But it may have fed on the larva of this bracon. I had myself suspected *M. Greeni* to suffer from the attack of a chalcid enemy and actually indicated such a probability in the chart accompanying the paper on the insects associated with lac.[5] However, Negi and Glover have taken no cognisance of this fact. This is said to show I was on the look out for a Chalcid parasite of *M. Greeni* but found no evidence in the above mentioned larva particularly as they mention *Eupelmus* "deposits on the stages of *M. Greeni* only if covered with a cocoon" which could not have escaped notice.

From the studies of lac parasites I conclud ed[5] that the lac insects, their par sites, the hyperparasites, and the suprahyperparasites are found in decreasing order. Thus when *Eupelmus* is found as a hyperparasite, its immediate host, the *Eublemma* caterpillars must have been found in even larger numbers. Gernet, who first discovered *Eupelmus*, actually found *Eublemma* caterpillars in larger numbers, exactly as the theory anticipates. The negative record, by Gernet, of any bracon excludes *Eupelmus* from acting as a superhyperparasite of lac. Gernet had also found the pupa of the most common internal parasite of lac, *Tachardiæphagus tachardiæ*, How. Thus Gernet's accurate observations are complete in themselves for the two parasites,*Eupelmus* and *Tachardiæphagus* were found together with their hosts, *Eublemma* caterpillars and *Lac* insects. If we grant with Negi and Glover both the parasites were endoparasites of lac, *Eublemma* caterpillars would be assumed as immune, in spite of the large numbers Gernet actually records. My study of the parasites of lac tells me, to increase the hosts in large numbers is to invite their enemies. The parasite of *Eublemma* caterpillars would be a missing link in the insects associated with lac and would be an incomplete explanation, of Gernet's findings. To grant Glover and Negi s explanation of Gernet's records is to admit *Tachardiæphagus* and *Eupelmus* are equally important as endoparasites of lac. If this were so, previous observers would have noticed it and I have found no definite suggestion with regard to host/parasite interrelationship offered by Imms and Chatterjee which proved to be erroneous, and I am not prepared to make an exception in the absence of Negi and Glover having brought any objective information, in their favour. Glover[6] states his "study of parasiticism and hyperparasiticism is believed to be the first of its kind for an Indian insect" and it is certainly the only amphibious insect known, for it acts as an ecto- as well as an endo- parasite; we are really asked to believe *Eupelmus* has the following hosts: the *Lac* insect—a Coccid, *Machærota planitiæ*—a Cercopid, *Microbracon Greeni*—a Braconid, *Holcocera pulverea*—Lepidopterous insect, *Tachardiæphagus tachardiæ*—a Chalcid, and *Erencyrtus Dewitzii*, also a Chalcid; the last two are much smaller than *Eupelmus* itself and the hosts belong to three different families of insects. At the time when only one host was indicated and its endoparasitic

nature suggested by its unhappy name, *Eupelmus tachardiæ*, Clausen[7] remarked, in ignorance of my positive findings in support of his views, "In Ceylon (*Anastatus*) *E. tachardiæ*, How. is reported as parasitic upon the lac insect, *L. albizziæ*, but in view of our knowledge of the habits of the genus the record must at present be considered questionable." Glover does not know this objection nor has he ever cited any of my publications. Since my findings fall in harmony with the views of others, including Imms and Chatterjee and Clausen, the burden of proof rather than the comfort of reassertion lies on the side which claims to have done something first of its kind in India and even outside it.

Glover and Negi mention *Marietta javenensis* as synonymous with *Microterys Hautefuilli* and further indicate doubts as to who named the insect. I had myself reared the former insect which I considered of such a minor importance that I never felt called upon to mention it yet. Later on some of my specimens were sent to America where they are found in the National Museum bearing Lot No. 1783, dated 16 February 1929. Some four years ago I created a new generic name and the insect is to be called *Lakshaphagus Hautefuilli*.[8] I am here reminded of what the late Prof. Lefroy[9] wrote, "Indian lac experts seem to be asleep and not to know anything of . . ." the literature on lac, a fact which is most easily demonstrated in the writings of Glover and Negi. Glover and Negi refuse to admit plurality of lac species but if they rear parasites from Chamberlin's *L. rangooniensis* which is a later name for my *L. chinensis*, they would obtain the specific chalcid parasite, *Lakshaphagus Hautefuilli* and may save themselves the unhappiness of confusing two parasites for one.

With regard to the monophagy of *Eublemma amabilis* they seem to imply it has been known for some time. If so they would cite a concrete reference, rather than make a vague mention. I hope to reply to their other disparaging remarks, after reading the statement, if any.

S. Mahdihassan.

Abid Manzil,
Hyderabad (Deccan),
*April* 23, 1935.

[1] Negi and Glover, *Curr. Sci.*, 1935, 3, 426.

[2] Glover, *A Practical Manual of Lac Cultivation*, Calcutta, 1931.

[3] Glover, *Bull. 21, Ind. Lac Res. Inst.*, Ranch Calcutta, 1934.

[4] Mahdihassan, *Curr. Sci.*, 1935, 3, 365.

[5] Mahdihassan, *J. Sci. Assoc. Maharaja's Col* Vizianagram, Oct. 1925, p. 64.

[6] Glover, *Bull. 21, Ind. Lac Res. Inst.*, p. 9.

[7] Clausen, C. P., *Annals Ent. Soc. Amer.*, 192 20, 470.

[8] Mahdihassan, *Arch. f. Protistenkunde*, 1931, 7 170.

[9] Maxwell-Lefroy, quoted in the Preface to J. *Pidance's Report on Lac Refining*, by Mahdihassa Osmania Univ. Press, Hyderabad (Deccan), 1930.

## *Pongamia glabra* Leaf Gall Former.

Massee in his paper "A new species of gal mite from South India"[1] described the mit *Eriophyes Cheriani*, on my authority, as th cause of the galls found on the leaves o *Pongamia glabra* Vent. Mani, in his publi cation entitled "The rôle of the mit *Eriophyes Cheriani* Mass, in the Cephalonio galls of *Pongamia glabra* Vent."[2] stated tha the mite is "not the true gall maker but onl a secondary organism which temporaril inhabits the galls" and "that there is abso lutely no doubt as to the gall maker whic is a Cecidomyid." In his second publica tion "A note on the polypoid (Cephalonion galls of *Pongamia glabra* Vent.",[3] Man resiled from his previous statement an stated that "though found in the gall th mite is not primarily responsible for it formation. The gall is originally formed b a minute undescribed Itonidid fly and onl certain minor changes in the gall are pro duced by the mite." In his third publica tion "Dispersal of gall mites by gall midges," Mani stated that "the midges and the mite develop in the same gall for which both o them appear to be responsible." In hi latest publication "Studies on Indian Itoni didae",[5] Mani reiterated that both the mit and the midge are responsible for gall forma tion and further stated that "neither o them alone produce such galls."

In view of this controversy and with view to settle definitely whether the mite by themselves could produce galls, certai inoculation experiments were devised an conducted at Coimbatore. These experi ments were so conducted that the experi mental plants were free from any Itonidi at any stage. The results of the experiment have been such as to enthrone the mite onc more to its former position, *viz.*, the tru gall maker. It is not known why in hi experiments Mani was not able to get gall by mites. Mites were introduced by m

when the leaves were very tender, almost when these were in the bud stage. If the mites are introduced after the leaves have developed, it is seen, that the galls formed are either very few in number or they will not be formed at all.

Since the Itonidid by itself cannot produce galls as admitted by Mani and since the mite by itself can produce galls as seen from my experiments I think Mani should revise his views and admit that the mites are the true gall formers.

M. C. CHERIAN.

Agricultural College and
Research Institute,
Coimbatore.
*March* 19, 1935.

[1] *Ann. and Mag. Natural History*, 1933, 11, 201.
[2] *Ann. and Mag. Natural History*, 1933, 12, 138.
[3] *Proc. 21st Ind. Sci. Cong.*, 1934.
[4] *Curr. Sci.*, 1934, 3, 208.
[5] *Records of the Indian Museum*, 1934, 36, 427.

*Note.* Mr. M. S. Mani agrees with Mr. M. C. Cherian's findings and accepts his results as correct.

## A Central Nutrition Board for India.

YOUR editorial in the April number of *Current Science* is much to be welcomed. Several times during the last three years and especially in connection with some University extension lectures delivered at Calcutta in 1932 and lately in connection with the symposium on Vitamins, held under the auspices of the Indian Science Congress at Calcutta, I had occasion to stress the need for the establishment of a Central Nutrition Board for India. It is encouraging to note that some nutritional investigations are being carried on in India in different laboratories. While it is desirable in the interest of science that there should be some individuality about the researches that are being conducted at different centres, the necessity for a co-ordinating central organisation would appear to be paramount. Such an organisation may be entrusted with the task of (1) co-ordinating the nutritional work of different laboratories, (2) suggesting investigations of practical importance in relation to the varying climates, soils, habits, traditions, availability of food-stuffs, etc., in different parts of the country, and, especially, in relation to the purchasing power of different classes of people, and (3) making the results available to the general public in simple non-technical language.

This board should work in close co-operation with the Imperial Agricultural Council and with the chief medical organisations of the country. It would be a great thing if your editorial can stimulate thought in this direction and lead to the establishment of a committee to go into the proposal in detail.

B. C. GUHA.

P. 109, Lake Road, Calcutta,
*May* 1, 1935.

# The Distribution of a Simple Epidemic Disease.*

By Prof. J. A. Strang,
*University of Lucknow.*

THE population N being divided into groups $v_0, v_1, \ldots, v_n$ in which $v_n$ means the number of persons who have experienced (or are experiencing) an *n*th attack of illness, it is shown that the numbers $v_n$ are determined by the equations

$$N = v_0 + v_1 + v_2 + \ldots\ldots\ldots + v_n + \ldots\ldots$$

$$\frac{dv_0}{dt} = -p_0 v_0$$

$$\frac{dv_1}{dt} = p_0 v_0 - p_1 v_1$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$\frac{dv_n}{dt} = p_{n-1} v_{n-1} - p_n v_n$$

where $p_n$ is the probability that an individual of the group $v_n$ will experience another attack within unit time.

Modifications are suggested for the cases in which

(i) only a finite number of attacks is experienced by each individual, either because the *k*th attack is always fatal, or because the *k*th attack confers immunity ;
(ii) migration occurs during the epidemic ;
(iii) births are included in the reckoning, affecting $v_0$, or $v_0$ and $v_1$, according as

* A resume of the lecture delivered under the auspices of the Faculty of Sciences, Lucknow University, Feb. 1935.

the child of infected parents is not or is infected at birth ;

(iv) individuals are removed by death or otherwise.

If the factors $p_n$ are independent of the numbers $v_0$, $v_1$, $v_2$,..... the differential equations are linear and homogeneous, and solutions are therefore linearly additive. The bearing of this on the application of results is pointed out when statistics refer, as they often do, to the sum of a number of outbreaks of disease and not to a single outbreak.

2. The equations are integrated in various cases.

(i) When the probability of infection is constant. Application to the occurrence of cancer. A set of statistics is discussed in some detail, and is shown to be better fitted by taking

$$p_0=p,\ p_1=\frac{r-1}{r}\,p,\ p_2=\frac{r-2}{r}\,p,\ldots\ldots,$$

where $r=4$ or 5, and represents the average number of persons in a household. The effect of increased liability with age is estimated and rejected as insufficient to explain the outstanding discrepancy. Probable reasons for the discrepancy.

(ii) Integration when $p_n$ is a function of the time and independent of $n$ ; when a constant mortality rate is introduced ; when the general mortality rate and that due to the epidemic are separately allowed for.

Conditions for the existence of a static condition are obtained and interpreted when $p$ is constant.

(iii) Integration when $p_n$ is not independent of the numbers $v_n$, but is proportional to the number of infective cases, and is therefore given by

$$p=p_0\Big[v_1+2v_2+3v_3+\ldots.+nv_n+\ldots.\Big]_{t-\mathrm{T}}^{t}$$

where T is the time during which infection persists after the occurrence of a given case, *i.e.*, the infective period.

Integration by stages when T is constant. The nature of the solution.

The equation

$$\frac{dv}{dt}=p\ (\mathrm{N}-v)\ [v-\mathrm{V}\ (t-\mathrm{T})]$$

and its exact solution by means of the substitution $\mathrm{N}-v=\dfrac{1}{w}$

First approximate solution. Application to the Great Plague of London.

Second approximate formula valid near the beginning of the epidemic when T is constant.

An approximate solution is obtainable even when T is not constant, by substituting for $\mathrm{V}\ (t-\mathrm{T})$ a mean value $k$. The solution

$$\frac{v-k}{\mathrm{N}-v}=\frac{u-k}{\mathrm{N}-u}e^{(\mathrm{N}-k)\,pt}.$$

Simplification when N is large compared with $u$, $v$, $k$ to $v-k=(u-k)\ e^{\mathrm{N}pt}$.

Application to plague statistics. The evaluation of $k$ furnishes an approximate value of T, and it is shown graphically that the variation of T closely follows changes in the relative humidity of the atmosphere. Effect of temperature and humidity on the rat flea, and its connection with the above.

## Exploration of the Sea.

THE report of the delegates of the United Kingdom of the 27th meeting of the International Council for the exploration of the Sea, held in Copenhagen from June 4–11, 1934, contains very useful recommendations for preventing the capture of young fish below the size at which they can be sold at remunerative price for the food of man, thereby assuring a continuity of stock. The regulation of the size of the mesh in the trawl nets and the imposition of a size limit for food fishes which may be landed for sale, formed important subjects of discussion and the Council stated that with a view to ultimate solution of all questions connected with the exploration of the seas it is essential that each Government should arrange for further observations to be carried out by competent observers not only in research vessels but also in commercial vessels and fish markets.

# Research Notes.

## The Dutch Cosmic Ray Expedition.

PROF. T. CLAY and his collaborators have published a series of papers dealing with the results of the Dutch Cosmic Ray Expedition, in *Physica*. The results reported are very valuable and interesting. They find that there is not only the magnetic latitude effect but also a magnetic longitude effect ascribed to the eccentricity of the earth's magnetism. They have investigated the variation of the intensity of the cosmic rays with respect to the altitude, the atmospheric pressure and the presence of clouds. The variations in the penetrative power of the rays with the magnetic latitude has also been investigated and the results obtained have been published in the recent number of *Physica* (April 1935).

## Heavy Water Plant.

BROWN AND DAGGETT (*J. Chem. Phys.*, 1935, **3**, 216) have described an improved type of laboratory equipment for the production of deuterium oxide which operates at a higher efficiency than has been previously reported. The electrolysis of a 3% solution of pure sodium hydroxide is conducted in steel cells of seamless tubing which serve as cathode, the anode consisting of nickel plates. The cells are operated at 100 amperes in four stages, the concentration of the deuterium oxide being 2·5, 12·0, 60·0 and 99% respectively at each stage. The gases generated by electrolysis are as usual made to recombine, and the entire design is explosion proof. The residue obtained in the fourth stage is distilled and subjected to an additional stage of electrolysis. The gases so obtained are mixed with pure oxygen and burnt in a silica jet inserted in a pyrex condenser resulting in the production of heavy water of the highest purity.

M. P. V.

## Electrolysis of Extremely Dilute Solutions.

THE literature regarding applicability of the Nernst's law of variation of potential with concentration, $E = E_0 + RT \log_e C$, at very dilute solutions has been contradictory (*e.g.*, Schmid, Vögele and Winkelmann, *Helv. Chim. Acta*, 1932, **15**, 393). M. Haissinsky has now shown (*J. Chim. Physique*, 1935, **32**, 116) that if careful precautions are taken about equilibrium conditions, etc., Nernst's law is found to be applicable right down to such low concentrations as $10^{-5}$ to $10^{-12}$ *n*. He has in particular measured by the method of Hevesy and Paneth the critical potential of cathodic deposition of bismuth at these great dilutions, using RaE and ThC as radioactive indicators, and finds a progressive change of potential with concentration in accordance with Nernst's law.

M. A. G.

## High Pressure Phenomena.

BRIDGMAN (*Reviews of Modern Physics*, 1935, pp. 1-33) has presented a short account of the theoretically interesting aspects of high pressure phenomena. A simple computation shows that the changes within the atom that take place under pressures attainable at present should be small although appreciable. The nature and magnitude of the interatomic changes are closely connected with the law of interatomic forces. The original theory of Born based on the Bohr atom, the empirical ninth power law and the exponential law emerging from wave-mechanical considerations are all found to be more or less short range approximations, and fail to reproduce the volume changes at high pressures. The study of the variation of the thermal coefficient of expansion with pressure leads one to the surprising result that a system may acquire negative values for entropy at high enough pressures; this is caused by the fact that we are measuring entropy with respect to a system in which atom is an inviolable unit. An examination of compressibility of liquids at different pressures reveals a large amount of "slack" between molecules at low pressures; increasing pressure removes the slack rapidly and the compressibility is high. At higher pressures, when the slack has been removed there remains only the compressibility of the molecules and the "Schottky shrinkage" whence the compressibility is low. The nature of the variation of the thermal coefficient of expansion with temperature shows that the effect of pressure is to make the *atom* rather than the *molecule* the individual unit of structure.

There have been a number of speculations regarding the form of the melting point curve at high pressures. They are: (1) the occurrence

of a critical freezing point, (2) a rise of the curve to a maximum followed by a fall, (3) a rise to an asymptotic temperature at infinite pressure, and (4) an indefinite rise with pressure and temperature. The present experimental data tend to support the last prediction.

As regards the polymorphic transition amongst solids there is no regular form for the curve. The only generalisation possible seems to be that it never ends in a critical point, which shows the non-existence of a continuous transition from one type of crystal lattice to another—"a gratifying check on the validity of our picture of the constitution of a crystal"! The solid-solid equilibrium is not a mobile one so that one finds a range of pressures and temperatures over which either of the forms may exist. In the interpretation of these equilibria it is often necessary to assume that the attractive centres are effectively located on projections and not at the geometrical centres of molecules.

Several other properties such as viscosity, conductivity, etc., have been investigated at high pressures, but their theoretical interpretation is beset with difficulties.

Certain fascinating speculations are possible regarding the effects of extremely high pressures as exist in the stars. Matter in such highly compressed state has been shown from astronomical evidence to have a density of the order of 100,000. A theoretical consideration shows that such matter cannot exist in a crystal lattice but it should more nearly correspond to a jelly at ordinary temperatures. The matter as we usually find is confined to a narrow diagonal band rising from near the origin in the extended pressure-temperature plane; on the high temperature side of the band it dissociates to a gas of electrons and nuclei and on the high pressure side it collapses to a "pressure-squash", possibly having neutrons, electrons and protons as the units of structure.

K. S. G. D.

## Chemical Properties of Elements 93 and 94.

REGARDING the existence of elements of atomic numbers greater than 92, there has been much controversy. For the correct interpretation of Fermi's results on the uranium bombardment a discussion of the properties of elements 93 and 94 is necessary. Grosse (*J. Am. Chem. Soc.*, 1935, **57**, 440) has deduced the chemical properties of elements 93 and 94 according to the periodic law and Bohr's theory. There are two possibilities. Either elements 93 and 94 are the highest homologues of manganese and iron respectively and may correctly be termed ekarhenium (En) and ekaosmium (Eo), or they belong to second group of rare earth elements according to N. Bohr. The former seems to be more probable.

Ekarhenium will have valencies up to 7, form the highest stable oxide $En_2O_7$ which will melt below 375°C., be reduced by hydrogen at elevated temperatures, form an acid with water and may also be basic with strong acids analogous to uranyl salts. Ekarhenium heptafluoride will be very volatile and will hydrolyse with water. Ekaosmium will also have different valencies up to the maximum of 8. The highest oxide $EoO_4$ will boil below 200°C., be a weaker oxidising agent than $OsO_4$. The highest halides will be volatile and readily hydrolysable.

According to N. Bohr, somewhere beyond uranium a "second group of rare elements," *i.e.*, elements with similar properties, is to be expected. The additional electron between successive elements will be bound in a lower quantum level and not be available as valence electron. Assuming that the filling of the lower quantum level begins in uranium, uranium would correspond to cerium in the first group of rare earths and elements 93 and 94, also 95 and 96, etc., would all have properties very similar to element 91.

A decision as to the nature of these elements can also be made by calculating the energy levels of the trans-uranium elements.

K. S. R.

## Effects of Lactose on Growth and Longevity.

THE nutritive value of lactose has received very little attention in the hands of pediatricians, in spite of the fact that this sugar forms a major constituent of the solids of milks; the solids of human milk contain as much as 50 per cent. lactose. Whittier, Cary and Ellis (*J. of Nutrition*, 1935, **9**, 521) have reported the results of their experiments on the influence of lactose feeding on the body weight and longevity; significant differences between lactose-fed and other sugar-fed laboratory animals have been found. Thus lactose caused more rapid growth of young rats than sucrose and the animals, in general, lived longer. Sucrose feeding was conducive to fat accumulation both in rats and pigs. The rate of growth on lactose rations is evidently not accountable on the

basis of stimulation of acidophilic organisms in the lower intestine, since dextrin has not the same influence on growth as has lactose.

B. N. S.

## Brains of Deep Sea Fish.

WILLIAM M. SHANKLIN (*Phil. Trans. Roy. Soc., Lond.*, 1935, **B. 516**) has made an important contribution to our knowledge of the structure of the brain of three deep sea fish,—*Ciaphus dumerili*, *Saurida suspicio* and *Bathypterois articolarphenox*. These rare specimens were collected by the Bingham Oceanographic Expedition off the Cat Islands (Bahamas) in 1927. The author gives exhaustive accounts of the various nuclei and fibre paths in the diencephalon and mesencephalon regions of the brain. In important structural details, the three fish differ considerably from one another. The brain in the examples investigated has undergone considerable modifications over the normal teleostean brain. The author states "However, it will be impossible to evaluate the full significance of these modifications until more is known concerning their natural history and until more extensive studies are made on the deep sea fish."

A new finding reported in this paper is that the forebrain bundle, which normally terminates in the region of inferior lobes, passes around the outer edge of pars rotunda and turning dorsally and passing adjacent to the ascending gustatory tract reaches the sensory root of the trigeminal nerve. The author explains this as a mechanism whereby the olfactory impulses of the second and third order are relayed direct from the forebrain to the cranial nerve centres. That the torus longitudinalis is closely associated with the optic tectum is clearly evidenced by its complete absence in the brain of nearly blind fish, *Bathypterois*. The gustatory mechanisms are highly degenerate in the brains of the deep sea fish.

## New Secondary Sex Character in *Salientia*.

IN distinguishing sex among *Salientia*, size of individuals and the presence or otherwise of a vocal sac have been largely used. Lately, after an exhaustive comparative study of the larynx, the presence of an œsophageal process was almost made a sex determiner in the female Ranid individuals. Mr. Liu (*J. Morph.*, 1935, **57**, 131) having studied 91 genera and 553 species, has come to the conclusion that a series of connective tissue bands which extends the entire length of both layers of obliquous muscle, is characteristic of only the male and he labels it "The Linea Masculina". This is found only in adult males and it is suggested that it may be associated in some way with voice production.

## Development of the Sense Organs of the Larva of *Botryllus*.

C. GRAVE AND G. RILEY (*J. Morph.*, 1935, **57**, 185) having studied the development of sense organs of *Botryllus* larva have come to the conclusion that these organs find no homologue in the same of Molgula and Amaroucium. In *Botryllus*, the statolith appears as a single club-shaped cell. The light sensitive organs appear as 5 small filaments, each from a ganglion. These filaments penetrate into a cavity formed in the statolith, which becomes later pigmented.

## Hyobranchial Apparatus in Plethodontidæ.

THE plethodontid salamanders are highly specialised individuals and are divided into 16 genera. J. Piatt (*J. Morph.*, 1935, **57**, 215) having studied the skeleton and muscles of the hyobranchial apparatus interprets the phylogeny of the family in a slightly different way from what is accepted to-day. Three separate lines are derived from a primitive plethodontid stock; one resulted in the Desmognathus group, the second gave rise to the Stereochilus and Gyrinophilus groups while the third ended in Plethodon and Oedipus groups.

## The Origin of Potash-Rich Rocks.

WITH his usual brilliance R. D. Terzaghi has offered a solution (*American Journal of Science*, No. 172, Vol. 29) for the most vexed question in petrogenesis, namely, the origin of potash-rich rocks. He has fully discussed the well-known hypothesis of Bowen where he postulates the reaction between Orthoclase and Anorthite, and the equally well-known suggestion of Vogt for the origin of such rocks. Field examples have been cited to show the production of granites and potash-rich rocks by the intense felspathisation of sedimentary and metamorphic rocks. Experimental observations of Detrich and F. W. Clarke have already indicated the increase of potash soda ratio during

the weathering and alteration of rocks and soils. Washington's analyses further show that the devitrification of volcanic glasses tend to increase the potash ratio of the rocks. Therefore Terzaghi's suggestion that the process of felspathisation is more prevalent than we suppose is a fruitful line of research for petrologists working on the interesting problem of the potash-rich rocks.

## Mineral Resources of Rajputana.

AFTER a quarter of a century's detailed work in Rajputana Dr. A. M. Heron of the Geological Survey of India has just now published (*Transactions of the Mining and Geological Institute of India*, Vol. 29, Pt. 4) a comprehensive account of the mineral deposits of that vast area. In the words of the author "Rajputana is not rich in mineral wealth either actual or potential," but yet he has located about fifty minerals including some building stones giving the necessary details for the prospector. It is only coal, sandstone, marble, slate and gypsum that are being continuously worked, giving employment for a large number of people. Some of the old workings have been stopped due to want of proper transport facilities. Of the other deposits none has any economic importance either present or potential.

The wealth of information contained in the book is so useful, as to make it an indispensable guide to any capitalist undertaking prospecting or mining operation in Rajputana. The author has given copious references of much value and the book gives a complete idea of the economic geology of this area. Since the book has been "designed to those who desire to go to Rajputana to make their fortune or otherwise," a mineral map would have been of much value especially to those living outside Rajputana.

Dr. Heron richly deserves to be complimented for the very valuable and authoritative work which he has brought out for the benefit of both geologists and mining engineers in and around Rajputana.

# The Journal of the American Museum of Natural History.

THE December (1934) number of this popular magazine is full of interesting articles. The contribution by R. T. Hatt on the habits of Pangolins of Asia and Africa is a fascinating account of these queer animals which are little known but much misunderstood. These bizarre mammals have exchanged their coat of hair for one of large overlapping scales, and possibly in consequence of their feeding on termites, they have lost their teeth, and if it is compensation at all, they possess powerfully developed claws for dismantling the termites' nests. Like the millipedes, these animals roll themselves up into balls when disturbed and also emit a hissing noise. Their long tongue which is prehensile and is coated with viscid mucus, is an adaptive modification for gathering up large number of ants. Equally interesting is the article on Wild Bees by T. D. A. Cockerell who has recorded the strange nesting and feeding habits of a number of species of solitary and social bees. Among these, mention may be made of such interesting forms as the peculiar *Nomia*, the large *Megatrichia*, the tiny *Perdita*, the leaf cutting *Megachile* and the long-tongued *Melitoma*. The account of Earthquakes and of the instruments that record these movements, by Chester A. Reeds, has a topical interest and the article on the "Haunts of the Wailing Bird" by Alfred M. Bailey gives a description of not only this but also of other birds occurring in the typical Florida's meandering water-ways.

The January and February (1935) issues of this Journal are as usual full of readable articles. In the January issue, Edwin A. Colbert gives a beautiful account of those grassy plains of what is now Nebraska, inhabited by animals long since extinct. These are brought to life before the mind's eye, by a vivid description of the reconstructed fossils of weird Miocene animals.

Is it feasible to organise and publish a Journal of this type in India?

# Jute and Allied Fibres.

By K. Biswas, M.A.,
*Royal Botanic Garden, Calcutta.*

ATTEMPTS have been made from a very early period to test different types of fibres allied to jute fibres and to replace jute fibres by fibres of some other species. The fibres allied to jute are well known to cultivators for some time and adulteration of jute fibres of commerce is not uncommon. Commercial people dealing in jute carry on transactions either to their advantage or disadvantage in proportion to their knowledge and experience of distinguishing the genuine fibres of jute from the rest while handling the stuff in the market. Some of the fibres are so much allied to jute fibres that it is by no means an easy task of distinguishing between two or several fibres if mixed up together. Of such fibre-yielding plants may be mentioned *Hibiscus cannabinus* Linn. (Mestapat), an annual or perennial prickly herbaceous shrub. This species is reported to grow wild, east of the Northern Ghats but generally cultivated for its fibres in Chota Nagpur, districts of Meerut, Northern Oudh and extensively cultivated in Central and Southern India. It is also reported that the plant is not uncommon in the lower Himalayas ascending up to 3,000 feet in elevation. In Dacca, East Bengal, the plant forms the chief material in the manufacture of paper. The species is a well known medicinal plant. The fibres of this species are very much allied to jute fibres, and are profusely employed in Bengal for the purposes of or as a substitute for jute in the manufacture of fishing nets and other articles of commerce.

Jute belongs to the genus *Corchorus* of the family Tiliaceæ. There are about forty species under this genus which are distributed throughout the tropical parts of the world. Out of this total number only eight species are wild in India. Of these eight species again only two species *Corchorus capsularis* L. and *C. olitorius* L. are the chief source of the supply of fibre-jute or gunny. The jute plant is an annual, erect, tall, little-branched herbaceous shrub. The fibre is beaten out of stems after cutting and retting in water. The above two species of jute (pat) proper are grown chiefly in Northern, Central and Eastern Bengal and are not available in any other provinces of India. The place of jute fibres is generally taken in other provinces by *Cannabis sativa* (Indian Hemp fibre), *Crotalaria juncea* (Sunn-Hemp), *Hibiscus cannabinus* (Deccan or Ambori Hemp) and sometimes *Malachra capitata* (Ran or Ban-bhendi) and *Sida* sp. (Berala). There are two other Hibiscus species whose fibres are also closely allied to jute (1) *H. Abelmoschus* Linn. (The Musk Mallow) a bushy herb which grows during the rains and flowers in cold season, occurs throughout the warmer parts of India. (2) *H. Sabdariffa* Linn. (The Rozelle) an annual, glabrous, unarmed herb with purplish stem which is generally cultivated throughout the hotter parts of India. Adulteration of jute fibres with those of Hibiscus sp. or identification of one of these fibres as jute fibres appears to be of daily occurrence in commerce.

I have recently had an opportunity of examining such fibres particularly of jute and Hibiscus through the courtesy of Mr. M. C. Ghose, the Chemical Examiner, Customs Department, Calcutta. I offer my best thanks to Mr. Ghose for favour of his placing the authentic materials at my disposal. I understand investigation on a sound footing is likely to be in progress in Mr. Ghose's laboratory. Due to export of various fibres and different kinds of foreign cotton and woollen goods at present pouring in Calcutta markets, the distinction of different qualities of fibres is nowadays gaining considerable state importance.

The writer realises that such an investigation can be best carried out by chemists, physical chemists and plant physiologists. He, therefore, by contributing this article, invites their suggestions for a practical, simple and speedy method of distinguishing various kinds of fibres from genuine jute fibres, and also of ascertaining comparative value of various qualities of genuine cotton and woollen goods from spurious materials. Such a discovery will undoubtedly be of considerable importance to commercial and industrial people of this country. Their work is likely to have a far-reaching value. But in the meantime it might be worth while to report here the results of my examination of jute and Mesta fibres, as also conclusions arrived at from experiments carried out on these two fibres by some of the previous workers.

Macroscopic examination shows that jute fibres are more silky to the touch, very pale brown, finer and more pliable or elastic than those of Mesta fibres which are slightly deeper brown, coarser and harsh. Both are combustible but jute appears to be quicker in catching fire and less resistant to combustion. Mesta fibres seem to support combustion to a certain extent.

Microscopic examination reveals that both fibres are bast fibres and are composed of prosenchymatous cells cohering together in bundles by dovetail arrangement. The thickness of the cell-wall varies at both the tapering acute or acuminate ends in ultimate fibre. By ultimate fibre is meant a single prosenchymatous cell of the bast fibres which might be separated out by maceration. The ultimate fibres of Mesta (*Hibiscus cannabinus*) vary from 1.5 to 4 mm. in length and 12 $\mu$ in width at the middle. They are nearly of the same length and width as those of jute, which vary from 1 to 3 mm. in length and nearly 12 $\mu$ in width. The thickness of the wall of both the fibres is 4 $\mu$ and the lumen is 4 $\mu$ broad. But roughness in Mesta fibres is evidently due to the nature of the encrusting substance lignin. Pliable more elastic composition of the cell-wall of jute fibres is due to this difference in lignification which occurs uninterruptedly over the whole area of the cell-wall. The nature of impregnation of the cell-wall in jute is neither true cellulose nor true lignin. It is a compound cellulose peculiar to jute and cereal grass type and in the case of jute it is known as lignocellulose. These lignocelluloses induce formation of Prussian blue in the greenish red solution produced by mixing ferric chloride with potassium ferricyanide. It is on this point, I mean, the nature of lignification, that

*Hibiscus cannabinus* (Mesta fibre) are of less textile value. Under hydrolysis (*i.e.*, boiling in one per cent. caustic soda, $Na_2O$) for five minutes, Mesta fibres lost 14.0 and after continued boiling for one hour, 19.5 per cent. of its weight and that under the same treatment jute fibres lost considerably less, *viz.*, 13.3 and 18.6. But what appears to be an important point of difference is, in spite of the slight difference in weight and tension experiment (I mean here the breaking strain) what I may call the steam experiment. Samples of the fibre exposed for two hours to steam at 2 atmospheres followed by boiling in water for 3 hours and again steamed for 4 hours lost only 3.63 per cent. by weight and jute 21.39.

It is due to the nature of lignification that my experiment shows that Mesta fibres are more tough, readily absorb lignin stain than those of jute fibres. Phloroglucin with HCl might exhibit difference of brightness in red colouration due to the depth and difference of lignification of the two fibres. Variation in moisture contents jute (10.3 per cent.) and pH (*i.e.*, acidity and alkalinity) of ash contents of the two fibres are also good differential tests.

The fibres as found in commerce are mainly bast fibres of bundles separated from the parenchymatous cortical layer. They are firmly coherent together and each bundle is composed of half a dozen to two dozens ultimate fibres which are of, as stated above, normal fusiform type. In transverse section they are thick-walled (due to encrustation of lignin) and polygonal. These allied jute fibres when treated with iodine are brown, deep yellow with aniline sulphate and jute instead of becoming bright red is purple with phloroglucin and hydrochloric acid. Concentrated solutions of alkalies have also a remarkable action on fibres of this group.

## Colloidal Electrolytes.

THE study of Colloidal Electrolytes has been engaging the attention of eminent physical chemists, and has attracted considerable interest from the theoretical and technical standpoints during the last twenty years. The term "Colloidal Electrolyte" was first used by Duclaux in 1909 for the class of substances having properties common to typical colloids and electrolytes; and later on the term was applied to various systems such as soaps, dyestuffs, proteins, starches, etc. It is therefore with deep interest that workers in Colloid chemistry and allied branches of science will study the monograph published by the Faraday Society (January 1935) embodying the papers presented for the sixty-first general discussion held by the Society. The discussion was held at the University College, London, from 27th to 29th September 1934 under the presidentship of Prof. F. G. Donnan, F.R.S.; and prominent Colloid Chemists from overseas attended the meeting. The subject was discussed broadly under two heads; Part I General (including theory and experimental technique) and Part II (special and technical) dealing with soaps, dyestuffs, proteins, starches and other materials.

Dr. Freundlich in the introductory paper (p. 4)* has pointed out the most significant property which distinguishes a colloidal electrolyte from an ordinary colloid. The former are characterised by the spontaneous formation of colloidal ions as contrasted with ordinary colloids where ions of an active electrolyte are present as necessary impurities. The ion micelles formed as a result of aggregation are responsible for the peculiar properties of colloidal electrolytes. (Osmotic Pressure, Conductivity, etc.) The colloidal electrolytes in general fall under three broad categories: (1) The ion micelles sensible to dilution with the formation of simple ions which can be dialysed (Soaps). (2) Ion micelles sensible to dilution with the formation of simple non-dialysable ions (Dyestuffs). (3) Colloidal electrolytes not affected by dilution (Proteins). The electrical properties of the ion micelles no doubt undergo profound changes in presence of strongly adsorbable substances.

The electrochemistry of colloids and particularly colloidal electrolytes has been extensively worked out by Pauli and his co-workers (*Electrochemie der Kolloide*, Wein, 1929). The essential idea underlying Pauli's work is that any colloid behaves like an ordinary electrolyte in the sense that its surface is dissociated giving rise to the constituent ions of the solid phase. The so-called ionogenic complex gets fixed to the solid phase giving rise to the charge on the particle. The "gegenions" are the ions situated on the liquid side of the interface. The electrochemical properties of sols of Gold and Platinum (p. 12) have been explained on the basis of the adsorption of complex acids formed during the preparation of the sols.

The problem of deciding the exact structure of the electrical double layer surrounding the colloidal particle has been one of great difficulty. Kruyt (p. 31) maintains that while the inner layer is formed from the material of the particle itself, the outer layer contributing to the $\zeta$ potential may consist of ions from other sources as well.

The question whether lyophobic sols can be considered to be colloidal electrolytes has been discussed at great length by Rabinovitch and his co-workers (p. 50). Their views differ fundamentally from those of Pauli and his school. While Pauli and Valko (p. 20) have assumed that potentiometric methods as applied to colloidal systems give an idea of the concentration of the "gegenions", Rabinovitch maintains (p. 57) that potentiometric methods can only measure the activity of the ions in the intermicellary liquid, which is quite different from the activity of the "gegenions".

It appears to us that a satisfactory theory of the nature of the interfacial layer should take into consideration the activity of the "Charging" ions, the "gegenions", and the ions in the intermicellary liquid. The adsorbed ions contributing to the charge on the particle may be the constituent ions of the solid phase. The binding of such ions to the surface of the particle is usually strong. The "gegenions" held electrostatically by the

* References are to the pages in the *Monograph* (*Trans. Far. Soc.*, 1935, 21, 1-421).

"charging" ions contribute to the charge on the solution side. Under the action of the electric field, the "charging" ions move with the colloidal particles. The ions in the intermicellary liquid do not contribute to the charge on the particles. Regarding the interpretation of the potentiometric results obtained with colloidal systems (*e.g.*, the hydrogen ion activity) the reviewers are of opinion that what they indicate is the hydrogen ion activity of the *entire* system. It is *not* the hydrogen ion activity of the micelle or its "gegenions" or the ions in the intermicellary liquid; but it is the *time* and *space* average of the activity of the entire system. The "gegenions" may vary in their activity from zero (non-ionised electrolyte) to unity (fully ionised electrolyte). The activity of the ions in the intermicellary liquid may be affected by the colloidal particles and the "gegenions", and the calculation of their influence is beset with difficulties. The $\zeta$ potential according to Rabinovitch is governed not only by the "gegenions" but also by the ions in the intermicellary liquid.

In discussing the behaviour of colloidal acids on dilution (pH, Conductivity, etc.) Rabinovitch (p. 55) working with $V_2O_5$ sols comes to the conclusion that the colloidal particles act as reservoirs which furnish acid to the intermicellary liquid as dilution proceeds. The results obtained by one of us (M. P. V. Iyer, *J. Mys. University*, July 1932) with stearic acid sols go to show that the behaviour of colloidal acids cannot be treated in all cases from the standpoint of Rabinovitch. In another paper, Rabinovitch (p. 281) questions the experimental results of other workers (Mukherjee, *Koll. Zeit.*, 1934, **67**, 178) in regarding colloidal silicic acid as a moderately strong acid so far as its electrochemical properties are concerned. Though Rabinovitch claims to have prepared colloidal silicic acid possessing neutral reaction and poor buffering capacity, his views are not shared by other workers. Treadwell (p. 299) points out that the colloidal silicic acid prepared by him by electrolysis, shows increased acidity on keeping, which he explains as being due to the polymerisation of the molecules of the acid, and not due to any contamination.

The extension of the Debye-Hückel theory to colloidal electrolytes which is beset with various theoretical difficulties has been tackled by Hartley (p. 31). It is considered unlikely that in pure solutions of colloidal electrolytes, activity coefficients smaller than those predicted by the extended theory of Debye and Hückel or micellar mobilities lower than those predicted will be found. It also follows as a necessary consequence that some kind of association between micelles and ions of opposite charge must occur. Donnan (p. 80) has applied his well-known theory of membrane equilibrium to the determination of molar masses, osmotic pressure and electrovalencies of different colloidal ions.

(*a*) SOAPS AND LONG-CHAIN ELECTROLYTES.

Soaps as colloidal electrolytes are of profound interest in view of their theoretical and technical importance. McBain and his co-workers have done pioneer work in this field. By measurements of the activity of soap solutions at 90°C., they have shown (p. 149) that they simulate a half weak electrolyte in concentrated solution due to the formation of small ion micelles. In dilute solutions however they exhibit the properties of moderately strong electrolytes. Mrs. Laing McBain (p. 153) has long been engaged in the correlation of the electrokinetic and electrolytic behaviour of soap gels and curds and has come to the conclusion that the migration of Sodium ions in curds and gels is practically unhindered. She is of opinion that the electrokinetic phenomena in soap gels should preferably be formulated in terms of the directly determinable migration velocity of the colloidal ions. The electrokinetic phenomena persist in such systems to very high concentrations of added electrolyte.

Since published data regarding the physico-chemical properties of solid soaps have been scanty hitherto, Bowen and Thomas (p. 164) have made a detailed study of the solid soaps as come out from the factory. They have correlated the hardness of the soaps to the rate of cooling and to moisture content. The temperature of solidification of the soap has been found to depend on the nature of the fatty acid present. Thus the hardness of the soap can be correlated to the titre of the fat charge. The effect of electrolytes present in soaps in altering their hardness and other properties like their efflorescence has been carefully examined.

Murray and Hartley (p. 183) from an examination of the variation of solubility of long chain salts such as soaps and cetyl sulphonic acids come to the conclusion that a true equilibrium exists between micellar and non-micellar forms. A large change in solubility at a certain temperature range (termed the "Kraft Point") has been ascribed to a large change in the ratio between micellar and nonmicellar forms.

The structure of soap micelles is of utmost importance and has been very clearly dealt with by Lawrence (p. 189). He postulates two main types of micelles: (*a*) The ion micelles wherein all the polar groups are pointing to the water. A change in concentration does not affect the size of these micelles; (*b*) The neutral or secondary micelles wherein there is crystalloidal association at the polar groups. An increase in viscosity is possible due to the latter type of aggregation. The phase changes in the micelles such as "Kraft point" are supposed to be due to the breaking up of the secondary micelles. That soap solutions are attacked by atmospheric influences such as oxygen and carbon dioxide has been pointed out by Löttermoser (p. 200) who has shown by careful experimental technique that variations in surface tension of soap solutions are the result of chemical reactions with $CO_2$ and oxygen at the surface.

Stewart and Bunbury (p. 208) have reviewed the industrial applications of colloidal electrolytes, particularly those newer types of synthetic organic compounds as have pronounced surface-active properties, which are finding wide application in the textile industry. These agents are chiefly the alkylated aromatic sulphonates, sulphuric esters of long chain alcohols, sulphonated castor oil and long chain quaternary ammonium compounds. Their chief applications are as detergents, wetting agents or emulsifiers. Some of these compounds have decided advantages over soaps in so far as they give a soft finish to the goods, and are not precipitated out in hard waters or acid baths.

(*b*) DYESTUFFS.

The formation of micelles of different types in dye solutions and the size of the particles have been recognised to be of great importance in the dyeing process. Valkò (p. 230) has attempted to

compute the size of the dyestuff particles by the study of the rate of diffusion across sintered jena glass membranes. His results show that acid dyestuffs are molecularly disperse, while the substantive cotton dyes are aggregated to form ion micelles. Congo red on account of its Zwitterionic nature is more highly aggregated in acid solution. The discrepancy between migration of dyestuff ions when freely diffusing and when under a potential gradient has been ascribed to the interionic forces between the ions of the dyestuff and the "gegenions".

Robinson (p. 245) has compared the highly purified dyes with commercial products. As with soap solutions, different types of aggregation in dyestuffs have been observed. Thus the micelles of *m*-Benzopurpurine are found to consist of at least ten particles with 25 per cent. of included sodium; while the micelles of Benzopurpurine 4B are rod-shaped and much larger in size. A study of the conductivity-concentration curves of many of the dyestuffs clearly reveals micelle formation even in dyestuffs like methylene blue which till recently were believed to be molecularly disperse. Morton (p. 262) has pointed out the importance of the colloidal constitution of the dye solution and the fine structure of cellulose fibres in the dyeing process. The pore diameter of viscose cellulose is much larger in the swollen than in the unswollen state. The size of the pore is one of the important factors that determines the kinetics of the dyeing process. The diffusion rate of rapid dyes through cellulose capillaries approaches that of diffusion in water, while for the slow dyes it is only $10^{-4}$ of the previous one. According to this view, aggregation of dyestuff particles will hinder the penetration of the dyestuff. The presence of small particles is quite essential for dyestuff absorption. Increase of temperature favours dye absorption as it causes a decrease in the size of the dye micelles. The rôle of the electrokinetic potential of the fibres in its relation to the absorption of the dyestuff has been emphasised by Freundlich, Valkò and others in criticising Morton's paper.

(*c*) PROTEINS.

Elöd and Schachowsky (p. 216) have studied the absorption spectra of mixtures of gelatin and tanning material to elucidate the nature of the tanning process. Using different complex salts of $Cr^{+++}$ and $Fe^{+++}$ they have arrived at the conclusion that the instability of the complex salt determines the tanning action. Regarding the nature of the complexes that are formed between the tanning material and gelatin, experiments with cobaltic hydroxide and gelatin go to show that molecular compounds may be formed as a result of the secondary valency forces on the gelatin particle. Elöd (p. 305) has also pointed out in another paper that the dyeing of protein fibres by acid dyestuffs is as a result of chemical combination. In the case of substantive dyes which are sodium salts of sulpho-acids, their colloidal characteristics must be expected to profoundly influence the dyeing process. 'Loaded' and 'unloaded' silk behave differently towards substantive dyes. The "loading" material hinders the free diffusion of the dye to the silk fibre. The structure of wool is different from that of silk in so far as when the former is stretched the secondary valency forces are oriented along the chain. So wool takes up more dyestuff when stretched than when unstretched. The intermicellar spaces in the fibres determine the penetration of the dyestuffs. These considerations enable us to explain the relative rates of dyeing of silk, wool and hides.

The Zwitterionic character of proteins has long been recognised, but it has been a moot point whether a protein molecule can be considered as a multivalent ion or whether each charged centre can be considered to be a single monovalent ion. These and other electrochemical aspects of proteins have been tackled by Jordon Lloyd (p. 317). The results so far obtained show that the charged centres in a protein molecule have not that freedom of movement observed with crystalloidal ions like sodium or chloride. The hydration centres and charged centres of proteins are closely related, and any electrolytic influence in which a protein takes part affects its hydration. The tendency of a protein to combine with an acid group is governed by the molecular size of the latter. The size and structure of the molecule as a whole has a strong influence on the physico-chemical property of every one of its active centres. Linderstrom-Lang (p. 324) by electrometric titrations of clupein has lent further support to the idea that the structure of the protein, *i.e.*, every charged centre has its profound influence on the electrochemical properties of the molecule.

Bigwood (p. 335) has studied the diffusion of electrolytes in swollen blocks of gelatin and put forward the interesting view that there is a concentration gradient of the micelles which gives rise to a concentration gradient of diffusible ions in the gel.

Weigert (p. 359) has made quite an interesting contribution on the rôle of colloidal electrolytes in photography. He has adduced experimental evidence to show that the intragranular phase consisting of gelatin particles is light sensitive. The photomicelles so formed have a profound influence on the development of the latent image.

The coagulating effect of metaphosphoric acid on egg-albumin has been made use of by Schofield (p. 390) in the estimation of proteins. He has shown that the metaphosphate ions get firmly attached to the amino groups of the protein, as the nitrogen of the amino group and the three Oxygen atoms of the phosphoric acid form a tetrahedral grouping round the central atom of phosphorus.

(*d*) STARCHES AND OTHER SUBSTANCES.

Samec (p. 395) who has done a great deal of work on starches has given quite a useful summary of his work. Starch solutions have a negative charge in contact with water. The phosphoric acid which is invariably associated with starch can be liberated by heating. It has been definitely established that the phosphoric acid is not adsorbed by the starch, nor are there any Werner complexes. All the properties of starch show that it is a polysaccharide ester of phosphoric acid. The synthetic amylophosphoric acids which are dibasic have been shown to be analogous in their electrochemical behaviour to the starch solutions. Thus starch consists of (*a*) the amylose fraction containing no phosphorus and (*b*) the amylopectin containing all the phosphorus. The two fractions can be separated by electrodialysis. The abnormally high osmotic pressure of the amylopectin is due to the hydrogen ions present as "gegenions". Electrometric titrations of amylophosphoric acid show two definite inflexions due to the neutralisation of the two hydrogen atoms. The migration

velocity of the amylophosphoric acid has also been determined. The conductivity of the sol is approximately a linear function of its concentration. There is a divergence between the conductivity of the sol and its potentiometric activity, in so far as the conductivity of the sol calculated on the basis of the potentiometric activity of the hydrogen ions is much larger than the observed value. This is quite a general phenomenon met with in colloidal systems. The viscosity changes of the starch solutions on the addition of electrolytes have been attributed to changes in hydration as well as to the electroviscous effect.

In this review, an attempt has been made to present some of the broad conclusions arrived at regarding the theory and applications of colloidal electrolytes. The monograph covering 420 pages of closely printed matter is undoubtedly an up-to-date and useful reference for workers in colloids.

M. P. VENKATARAMA IYER.
K. S. G. DOSS.

## Problems of Cereal Rusts in India.*

UNDER the auspices of the Indian Science Congress, 1935, held at Calcutta, a Symposium was held on the Problems of Cereal Rusts in India.

Dr. K. C. Mehta opened the discussion by reviewing his investigations into the rusts of wheat, barley and oats during the last 5 years.

He said that in the absence of alternative hosts on the plains the annual propagation and spread has been cleverly brought home to the continuous presence of viable uredospores in the hills, the spores living on self-sown wheats, barley and oats. The infection has been traced to the winds becoming laden with spores and the spores being carried long distances by upper currents of air. In the hills barberries and Thalictrum have been found infected with rust but the disease appears much after the appearance of rust on wheat.

The various devices for exposing slides at high altitudes invented by Dr. Mehta and Mr. Chatterji were then explained, and the time of the spread of viable rust spores correlated with the appearance of rust in the fields. There was striking correlation. The different physiological strains of rusts met with in India are few in comparison with those met with in U.S.A. and this was explained because the fungus could not intensively hybridise in absence of secondary or alternative hosts.

The annual loss due to rusts is enormous; control measures are breeding resistant varieties and effort to eradicate the disease in hills by suspension of wheat crop and vigorous destruction of the diseased material.

Dr. F. J. F. Shaw then read a paper by Dr. B. P. Pal on wheat rusts from the viewpoint of plant breeding. Dr. Pal emphasised that the only effective way to overcome the disease problem is by breeding resistant varieties. This is difficult in the case of wheat as the commercially desirable varieties and those possessing the highest measure of rust resistance belong to two different groups the members of which do not readily intercross. Further complexity is introduced by the existence of a large number of physiologic forms of the three wheat rusts and a variety resistant to some forms is usually susceptible to others.

He pointed out that along with these difficulties certain hopeful features exist such as the fact that a single genetic factor sometimes determined resistance to a group of physiologic rust forms and in that certain varieties which are susceptible in the seedling stage under greenhouse conditions later on develop in the field what is known as mature resistance, the latter being probably morphological in nature. Thus certain varieties appear to be resistant because the bundles of chlorenchymatous collenchyma in which the rust mycelium develop are small and separated by sclerenchymatous fibres. Again some varieties showing mature or field resistance probably owe their resistance to the fact that they open their stomata only after the morning dew has dried up so that germinating rust spores are killed before a means of entry is offered to them.

In conclusion Dr. Pal briefly mentioned the work being carried on in other countries and made some observations on the possibilities of breeding rust resistant wheats for India.

Mr. Burt said that he saw the Indian and European barberries growing side by side at Dr. Mehta's Simla laboratory and found that Indian barberries were resistant while foreign ones were susceptible. He thought that the question whether an embargo should be placed on importation of foreign strains would have to be considered, but, in the meantime, it would be very useful if systematic botanists throughout India would bring to the notice of the Imperial Council of Agricultural Research any instances of imported barberries being grown as ornamental plants or otherwise, so that the Council might see whether susceptible forms already exist in the country.

Mr. P. K. Dey said that while appreciating the great advance in the knowledge of the rusts brought about by the researches of Dr. Mehta, he could not be quite convinced of the disease being due only to the wind borne infection from the hills. He asked why lower leaves were affected in preference to top ones which received highest infection as the infection came from above? Also why was the whole field found to be simultaneously affected instead of random areas as would be presumed from the mode of infection. Possibility of the spores remaining dormant in the soil nutrients should not be completely abandoned. Protected and non-protected fields should be laid to prove definitely the mode of infection.

Dr. H. Chaudhury said that he had noticed a peculiar case at Lyallpur. Two distant plots of Australian wheat were found to be affected with rust but the indigenous varieties of wheat growing by the side of these plots had been found to be quite healthy. Did such cases normally occur?

Dr. Ramdas asked why emphasis was placed on upper layers of the air currents as being the

* The full proceedings will be published by the Indian Science Congress Association in due course.

carriers of the spores instead of the lower layer? Lower layers should not be neglected in such problems.

Dr. Nehru suggested that the electric cultures might be useful in checking the disease. A baby cine on a flying machine may be useful in collecting data of the spore distribution in the upper layer of the air.

Dr. Bagchi said that there should be more intensive research in differentiating physiological forms. At present very small difference was deemed sufficient for forming a new strain. This practice should be discontinued and only after detailed study and recurring major differences should the division into physiological strains be made.

Dr. Mehta replied to the various points raised in the debate and said that he was not prepared to affirm at this stage that the alternate hosts had no part in the annual cycle of black and brown rusts. Circumstantial evidence, however, showed that the air currents laden with uredospores from the hills were mainly responsible for the disease in plains of India.

That loss of viability of uredospores was complete in the plains has been shown by experiments at his research station. Seed borne infection was non-existent. Greater humidity near lower leaves favoured spore germination; hence these are attacked in preference to top leaves. Differential host studies are in progress.

S. V. DESAI.

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# Easter Session of Scientific Societies, held at Bangalore. 18th—22nd April 1935.

## WELCOME ADDRESS.

IN welcoming the delegates, Dr. Gilbert J. Fowler emphasised the need for co-ordinating the forces and facilities at our disposal and referred to a formal agreement between the London Chemical Society, the Institute of Chemistry and the Society of Chemical Industry to set up a body to be called the Chemical Council. This was to consist of representatives of the three bodies, together with representatives of industry nominated by the Association of British Chemical Manufacturers. The object of the Chemical Council was to administer a joint fund for such common purposes as the maintenance of a library and for the co-ordination of scientific and technical publications.

He briefly indicated the characteristic activities as he saw them of the various bodies represented at the session. Few words from him were needed to support the high aims of the Indian Academy of Sciences with its President Sir C. V. Raman. It knew no limit to its scientific activities and strived to scale the peaks of human knowledge. Many of its publications were beyond the present understanding of the lay public who were content to await with interest the news brought from those high altitudes.

The Institute of Chemistry of Great Britain and Ireland concerned itself with maintaining a high scientific and professional status of the chemical profession throughout the British Empire, by holding examinations and by scrutinising very carefully the claims of applicants for its Associateship or Fellowship.

The Indian Chemical Society (Madras Branch) looked after the interests particularly of Pure Chemistry in India, a worthy daughter of the present Chemical Society of London.

The comparatively new science of Biochemistry was represented by the active body known as the Society of Biological Chemists, India, having its headquarters in Bangalore where it was a matter of pride to him that Biochemistry was first systematically taught in India.

Finally, he referred to the South Indian Science Association which fulfilled a very useful function in holding meetings for the discussion of matters of scientific, technical and general importance, but which could hardly find a place in more purely specialist societies. In this way it should serve as a very necessary link between the more recondite activities of scientific laboratories and their exposition to the general public.

## INAUGURAL ADDRESS.

In the course of his inaugural address, Sir C. V. Raman referred to the possibility of classifying the main species of nacreous shells on the basis of their internal structure as revealed by the nature and distribution of the halos when they are examined by transmitted light. The X-ray studies of the shells carried out in the laboratory supported the above results.

The reflection colours of nacreous shells, classified into transferable and non-transferable types by Brewster, were in fact found to be due to one and the same type, the result of diffraction phenomena. Microscopic examination revealed the intersections of the oblique layers of the material of the shell at the surface, which was responsible for the intense and variegated colours observed.

## RECENT ADVANCES.

*Structure of Molecules:* Dr. M. A. Govinda Rau.—An important consequence of the newer wave-mechanical theories of the structure of molecules is that the actual state of a complex molecule cannot be represented in general by a single chemical formula but only by a superposition of several states. These states have frequently nearly equal energies and on account of their superposition give rise to an energy of resonance and hence to a stability. There are other consequences of resonance, such as on the dipole moment and notably on the steric properties of molecules. The application of wave-mechanics has been generally very successful in explaining several of the finer details of structure of molecules.

*Chemistry of Rubber:* Mr. B. Sanjiva Rao.—After briefly referring to the work of Faraday and Tilden who established the relation of rubber to isoprene and of Weber and Harries who developed methods for its purification and studied many of its reactions, the recent work of Staudinger and Pummerer was reviewed. They improved the methods of purification and showed that rubber owes its characteristic properties to its chief constituent the rubber hydrocarbon and specially Staudinger by his fundamental work on the viscosity of high molecular weight substances showed that rubber consists of very long molecules in which over 1,000 isoprene molecules are bound

by means of main valencies into chains. The elastic properties are closely associated with the length of the chain. The saturated rubber obtained by hydrogenation is also elastic and is stable in air unlike the ordinary rubber which becomes brittle being attacked by oxygen. A reference was made to the excellent synthetic rubber from 2-chloro-butadiene and the great impetus which synthetic rubber research would obtain from Staudinger's work.

*Colloid Chemistry of milk in relation to infant feeding and humanisation:* Mr. M. Sreenivasaya.—The condition of the casein micellæ in its natural environment varies with different milks, the degree of its dispersion and its state of hydration being largely influenced by the content of (1) Lactalbumin, (2) the non-protein nitrogen and (3) the other crystalloidal constituents like lactose and salts. Milks having higher percentages of the components, in general, exhibit a higher degree of dispersion of their suspensoids and emulsoids and are more easily digestible. The fact that the digestibility of cow's milk can be enhanced by the addition of 0.5 to 1.0 per cent. urea, is a significant advance in the humanisation of milk.

The problem of humanisation was not merely a question of reduction and stabilisation of the colloidal particles of milk. The nutritive value of the dispersing and stabilising agents had to be considered in that connection. Attention was drawn to the limitations of humanisation imposed by an imperfect knowledge regarding the composition of the caseins and lactalbumins from various milks.

### Original Papers.

21 papers were presented before the Session:—Physics, 8; Inorganic and Physical Chemistry, 4; Organic Chemistry, 2; Biochemistry, 1; and Industrial Chemistry, 3.

### Public Lectures.

Rao Bahadur Prof. B. Venkatesachar, M.A., F.Inst.P., gave a Lecture illustrated by lantern slides on "Transmutation of Elements", a subject of great theoretical importance. Dr. V. K. Badami delivered an address on "Sugarcane in Mysore", a subject of high economic interest. The lecturer exhibited several specimens of improved canes.

### Social Events.

Sir Venkata and Lady Raman were "At Home" to the delegates and the elite of Bangalore, on the 18th April. On the 20th April, there was another "At Home" arranged by the Societies participating in the Session, at the premises of the Industrial and Testing Laboratory.

### Visits.

Visits were arranged to the Government Transformer Factory and Government Industrial and and Testing Laboratory. A whole-day excursion was also arranged for visiting the Mysore Iron Works, Bhadravati. At all the places excellent arrangements were made for the reception of the delegates.

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## Science Notes.

*A Study of the Boundary Lubricating Value of Mineral Oils of Different Origin.* (Lubrication Research Technical Paper No. 2. H. M. Stationery Office, Price 9*d*.).—This Report discusses the results of a more extended investigation on the lines described in Lubrication Research Technical Paper No. 1. That paper attempted to analyse the properties of commercial lubricating oils under boundary conditions but as two oils only (of unknown origin) were employed it was thought unsafe to base general conclusions on the results. In the present investigation oils of known origin have been employed and their properties as lubricants under boundary conditions have been correlated with what is known of their chemical constitution, particular attention being paid to the influence of wax. The results of a few preliminary experiments on the specific effect of the bearing surfaces are discussed.

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*The Evaluation of Glare from Motor Car Headlights.* (Illumination Research Technical Paper No. 16. H. M. Stationery Office. Price 1*s*. 6*d*.).—The present paper applies the results of previous research undertaken by the Illumination Research Committee, to the practical problem of assessing the actual glare arising from powerful motor car headlights. By the method described in the paper a "figure of merit" with respect to freedom from glare can be obtained for any proposed headlight system. No attempt is made in the paper to lay down an ideal distribution of light nor to prescribe an actual anti-glare headlight. The practical aim is to help designers of headlights and others interested to assess the merits of various distributions of light, without necessarily having to construct actual headlights to produce such distributions.

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*Atmospheric Pollution (Twentieth Report).* (H. M. Stationery Office. Price 5*s*.)—Smoke pollution affects us in many ways—the cleanliness of our homes, the air we breathe, the state of preservation of our historic and other buildings, the sunlight we enjoy and so on. Data regarding deposited impurity, suspended impurity, destructive gaseous impurity, obstruction of light are therefore of close interest. It is the purpose of the investigation of Atmospheric Pollution, the Twentieth Report of which is now available, to supply such data.

* * *

*Scientific Results of the Dutch Expedition* in Karakorum and the neighbouring areas in the years, 1922, 1925 and 1929-30.—The first volume which has recently been published, comprises the scientific results dealing with Geography, Ethnography and Zoology collected during Dr. Visser's three expeditions. The results referring to the other branches of science will be incorporated in the subsequent volumes. According to a notice appearing in the *Sunday Statesman* dated 31st March, the most thrilling pages of the book will possibly be those in which Dr. Visser describes the history of the discovery of Karakorum with dramatic simplicity. Mrs. Visser has given an account of her Ethnographical studies. Dr. Sunder Lal Hora of the Zoological Survey of India, has described the 418 specimens of fishes collected by Dr. Visser and his friends. 87

specialists have contributed to the first volume making it a scholarly production of great importance.

* * *

*Mount Everest Expedition.*—A fresh attempt to scale the Everest is to be made this year by a British Expedition under the leadership of Mr. Hugh Rutledge.

Mount Everest was 'discovered' by trigonometrical calculation 80 years ago. The first attempt to scale the peak was made in 1921 by Lieut.-Col. C. K. Howard Bury. In 1922, General Bruce with a party of experienced mountaineers reached a height of 27,300 feet only 2,000 feet remaining to reach the peak; with the experience gained in this attempt, General Bruce made a second attempt in March 1924 but unfortunately this too proved unsuccessful and the leader and also Mr. S. L. Mallory, another experienced mountaineer, lost their lives. 8 years later Mr. Hugh Rutledge led an expedition and reached a height of 28,000 feet, about 1,000 feet below the summit. Owing to the difficulty of negotiating the rocks covered with loose snow this attempt too proved futile. In the same year four British airmen flew over the peak at a height of 35,000 feet. They have taken a number of photographs and made several important observations and these are now available to the experienced leader, Mr. Hugh Rutledge, who is shortly to make another expedition this year.

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The All-India Modern History Congress will be opened by the Governor of Bombay, at Poona on June 8th. Dr. Shafaat Ahmad Khan has been elected President. A historical exhibition has been organised and tours to places of historical interest will be arranged for the delegates during the session.

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The International Congress of Neurology will be held in London from July 29th to August 2nd.

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The seventh International Congress on Industrial Accidents and Diseases will be held at Brussels, Belgium, from July 22–27.

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The tenth Congress of International Society of Surgery will be held at Cairo from December 30th to January 4th, 1936, under the presidentship of Prof. A. Von Eiselberg of Vienna.

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The fourth International Congress of Agricultural Industries will be held at Brussels from July 15–27.

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Professor Kenneth Aston of Cardiff has been appointed Professor of Electrotechnology, Indian Institute of Science, Bangalore.

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Dr. Ziauddin Ahmed, Member, Legislative Assembly, has been elected Vice-Chancellor of the Aligarh University.

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The Syndicate of the Annamalai University has appointed Dr. S. N. Chakravarthi, Professor of Chemistry, Annamalai University, temporary Vice-Chancellor, in the place of Mr. S. E. Ranganathan, on his retirement.

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Dr. R. P. Paranjpye, whose term of office as Vice-Chancellor of the Lucknow University, expires on September 15th next has been reappointed Vice-Chancellor for a further period of three years.

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The Director of Industries and Commerce, Government of Hyderabad, invites applications from *Mulki* candidates for 3 scholarships for 2 years for training in Sugar Technology at the Harcourt Butler Technological Institute, Cawnpore.

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It is understood that permission has been granted to Professor W. Norman Brown, Professor of the American School of Indian and Iranian Studies and Director of Fine Arts in Boston, for archaeological excavations in Sind. The excavation work is expected to commence during the next autumn.

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Mr. H. G. Champion, M.A., I.F.S., Silviculturist, Forest Research Institute, Dehra Dun (India), is leaving India for 8 months, on leave. Mr. M. V. Laurie, I.F.S., will officiate in his place during the period.

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From Moscow comes the announcement that before the close of the year a rocket aeroplane capable of flying at terrific speed will be piloted through the rarefied air of the stratosphere. The result of the experiment will be watched with the greatest interest as the possibility of using rocket-propelled machines for flying in the stratosphere, with the idea of eventually reaching the moon is being talked about by a large number of scientists.

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Dr. H. W. Dudley, Biochemist, Medical Research Council and Dr. Chassar Moir, London University Gynæcologist, have isolated an alkaloid from ergot, named ergometrine, which produces strong contractions of the uterus after 8 minutes, if administered orally, and within 4 minutes by hypodermic injection.

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Hydrogen of atomic weight 3—tritium—, the evidence for which was obtained by nuclear disintegration processes at Cambridge and at the Palmer Physical Laboratory, Princeton, has now been produced by Dr. P. W. Selwood of the Frick Laboratory at Princeton by the electrolysis of 75 tons of water over a period of 1 year. 0.5 c.c. of the precious fluid has thus been obtained. This type of hydrogen exists in a concentration of 1 part in ten thousand million parts of ordinary water.

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*The taste of 'heavy' water.*—Professor H. C. Urey and Dr. S. Failla who have compared the tastes of 'heavy' and ordinary distilled water conclude that the pure deuterium oxide has the *same* taste as ordinary distilled water. The 'dry' burning taste experienced by Professor Hansen, of Oslo, on tasting 'heavy' water thus remains unconfirmed.

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In the course of an article on "Animal Husbandry in India," appearing in *Statesman*, 30th March, Col. A. Oliver, Animal Husbandry Expert, Imperial Council of Agricultural Research Department, stresses on the need for organising Animal Husbandry Departments in every Province and State, "devoted solely to the interests of livestock and capable of carrying on systematic disease investigation and control and of giving

effective assistance and advice to villagers throughout the country in such matters as expert selection and registration of improved stock combined with better feeding of females and young stock; the proper selection and care of suitable sires combined with systematic castration of inferior males; and in the disposal of their stock and produce." In the past, there has been no organised effort and there has been none of that continuity from generation to generation without which no lasting progress can be effected in livestock improvement.

* * *

In the course of his presidential address delivered at the annual meeting of the Indian Chemical Society (Punjab Branch) Prof. Ruchi Ram Sahni dealt with "The Place of Science in Mass Education", a subject of very wide appeal. He outlined the constructive proposals for rationalising the education of pupils so as to make them well fitted for life. At home and at school, boys and girls should, throughout, be imbued with the spirit of science and the training should be so designed as to inculcate in the child a distinct bias in the direction of a proper scientific appreciation of facts and principles with which he may be brought into contact in the course of his studies or observation. "No subject of instruction is capable of exciting, stimulating and satisfying the same variety of tastes and interests and bringing the mind and the soul of the pupils into relation with their surroundings in the same intimate manner as the study of the sciences does."

* * *

*Stricken Formosa.*—A severe earthquake rocked Formosa on the 21st April and is the worst in the Japanese territory since the disaster of 1923, when about a hundred thousand deaths were caused. As a result of the recent cataclysm two Provinces were devastated and four large towns were severely affected. Nearly three thousand persons are reported to have perished, about ten thousand houses collapsed and more than eleven thousand were damaged. The total loss to property is estimated to exceed 10,000,000 yen. Fortunately the sugarcane industry has been spared. An oilfield in the stricken area is reported to have rocked severely releasing a gusher which caught fire, adding terror to the inhabitants.

Stricken Formosa has evoked the sympathy of the nations and offers of help are forthcoming from the American Red Cross and other organisations.

* * *

*Co-operation in Tea Research.*—With a view to secure personal contacts between the staffs of the various Research Institutes devoted to Tea Research, Dr. R. V. Norris, Director, Tea Research Institute of Ceylon, with Mr. Forbes of the Planters' Association, Ceylon, will shortly proceed to Java, where they will have every opportunity to study the Research Organisations. They will be accompanied in the tour by Mr. Carpenter, the Director of the Tocklai Experimental Station, India. Arrangements have also been made for Mr. T. Eden, Agricultural Chemist, Tea Research Institute of Ceylon, to visit the Tocklai Station and for Mr. Cooper of the Tocklai Station to visit the Tea Research Institute of Ceylon.

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The Kelvin Medal awarded by the Electrical Institute for outstanding Researches was presented to Sir Ambrose Fleming, the octogenarian inventor of the thermionic tube.

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Professor L. Ruzicka of the Technische Hochschule, Zurich, will be a visiting Professor at the Department of Chemistry, University of Chicago, during the summer quarter beginning June 15th. The Professor will give two series of lectures: (1) Special topics in the chemistry of alicyclic compounds and terpenes and (2) Selected topics in Biochemistry.

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According to a note appearing in "Chemical Age" the measures taken to eradicate malaria during 1934 as reviewed at a recent Moscow conference, include spraying from air craft over 600,000 hectares of marshland with Schweinfurt green and flooding 25,000 hectares with petroleum by the same means. 7,000 hectares of marshy ground have been drained. The Soviet Union has allocated 80 million roubles for fighting malaria in 1935. At the Conference, reference was made to the new synthetic anti-malarials, *Plasmozit* and *Akrichen*.

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We have just received the Supplement to the *Journal of the Zoological Society*, Muslim University, Aligarh, India, dealing with the zoological laboratories, their equipment and staff. This is one of the many well-equipped teaching universities in India coaching students for the B.Sc. (Hons.), M.Sc. and Ph.D. courses. Besides lecturing work, the list of research papers given at the end of the supplement gives us to understand that the members of the staff are also pursuing original investigations in Helminthology and we do not very well agree with them when they say on page 2, that "This is the only university institution in India where research in Nematology in relation with the Tropical Diseases of Man and the Domestic animals is carried out." It is such a pity that the "Muslim community has not yet realised the value of research." This narrow-mindedness is not an exclusive monopoly of the Muslim community. It is largely prevalent elsewhere also. We hope that this limitation will soon disappear, and in building up the reputation of any department it is necessary to have a capable director inspiring an enthusiastic band of workers besides possessing a good library. We expect to see all this in the zoological laboratories of the Aligarh University.

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The report on the Royal Botanic Gardens for 1933-34, which has been recently published, clearly points out the scientific and educational value for India of the Botanical Gardens. During the year considerable progress was made towards the enrichment of the Garden as a repository of the more useful and beautiful tropical and semitropical trees and shrubs. The garden of medicinal plants started sometime ago has been added to and renewed. Large exchanges with gardens abroad have been kept up. The requests for identification of specimens have been on the increase and the Royal Botanic Gardens have actively helped several institutions in starting reference herbariums. Thus, the School of Tropical Medicine, Calcutta, is building up a herbarium of medicinal plants with the help of the Royal Botanic Gardens and the Forest

Research Institute, Dehra Dun, received a collection of duplicate Malayan specimens. The report also mentions that a treatise on Indian Water plants intended primarily for distribution by the Malaria Survey of India for workers engaged in researches on the distribution of malaria carrying mosquitoes, is under preparation.

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We acknowledge with thanks the receipt of the following :—

"Journal of Agricultural Research," Vol. 49, Nos. 10 and 11.

"The Journal of the Royal Society of Arts," Vol. 83, Nos. 4296–4300.

"Biochemical Journal," Vol. 29, No. 3, March 1935.

"American Journal of Botany," Vol. 22, No. 3, March 1935.

"The Journal of Institute of Brewing," Vol. 41 (Vol. 32, New Series), No. 4, April 1935.

"Canadian Journal of Research," Vol. 12, No. 3.

"The Chemical Age," Vol. 32, Nos. 821–825.

"The Journal of the Indian Chemical Society," Vol. 12, Nos. 2 and 3.

"Experimental Station Record," Vol. 72, No. 2.

"Forschungen und Fortschritte," Vol. 11, Nos. 10–12.

"The Quarterly Journal of Geological, Mining and Metallurgical Society of India," Vol. 7, No. 1, March 1935.

"Monthly Statistics of the Production of Certain Selected Industries of India," No. 9 of 1934–35, December 1931.

"Functions and Organisation of the Indian Meteorological Department," Government of India, Department of Industries and Labour, 1935.

"List of publications of the Institute of Plant Industry—Leningrad, U.S.S.R.," for the year 1933.

"Report and Accounts of the Cocoanut Research Scheme for 1934," March 1935. Sessional Paper, Part 4, 1935.

"Cocoanut Research Scheme for 1933," April 1934, Sessional Paper, Part 5, 1934.

"Cocoanut Research Scheme for 1932," May 1933. Sessional Paper, Part 8, 1933.

"The Cocoanut Research Scheme, Ceylon," Bulletin No. 1, Report on the Soap Industry in Ceylon, November 1934.

Review of the activities of the Cocoanut Research Scheme of Ceylon," by Dr. R. Child (Reprint from the "Tropical Agriculturist," Vol. 83, No. 1, July 1934).

"Handbook of the Institute of Agricultural Research—Facilities of Study and Research," Benares Hindu University.

"Mathematics Student," Vol. 2, No. 4.

"Medico-Surgical Suggestions," Vol. 4, No. 4.

"Journal of the Indian Mathematical Society," Vol. I, No. 4.

"Nature," Vol. 135, Nos. 3412–3416.

"Natural History," Vol. 35. No. 4, April 1935.

"The Journal of Nutrition," Vol. 9, Nos. 3 and 4.

"The Journal of Chemical Physics," Vol. 3, No. 4.

"Journal de Chemie Physique" Vol. 32, No. 3.

"Research and Progress," Vol. I, No. 2, April 1935.

Inter-University Board, India—Annual Report 1934–35.

"Russian Journal of General Chemistry," Tome 4 (66), No. 9.

"Science Progress," Vol. 29, No. 116.

"The Indian Trade Journal," Vol. CXVII, Nos. 1501, 1505.

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## The Spirit of Research.

In an interesting address to the Fellows and Associates of the Institute of Chemistry at their Annual Meeting, Prof. J. F. Thorpe dealt with certain aspects of the profession of Chemistry both in academic life and in industry. (*Vide J. and Proc.*, 1935, Pt. II, p. 121.) Although these remarks were primarily intended for the chemists, they do nevertheless hold true for others as well ; it appears therefore to be of importance to extract the relevant portions of the address.

These remarks relate to the application of team-work for the solution of important and urgent problems. This idea of team-work is the legacy of the Great German Schools led by Bensen, Victor Meyer, Fischer and others and in England by Perkin Jr. of recent memory. In all these instances, the individual was deeply engaged in one major problem with a number of research workers, while other questions of moment were also examined by him side by side. Thus, individualism marks out generally the man of superior merit and it is an innate quality which can neither be manufactured in the laboratory, nor its power be suppressed or hidden for long. Those who lack it, are mere workers under direction, however great their manipulative skill may be. Unless this quality is discovered and given free play, the force that directs other minds becomes dormant and rusty. In the present day, team-work has lost this sense of expression of the individual and is replaced by grouping a number of workers, working for the state under some recognised leader. This feature is the resultant of war-time activities, when all brains and manipulative skill were harnessed by one, two or more powerful individuals, who co-operated among themselves. These were extraordinary circumstances.

Post-war conditions have not tended to modify the above system but extended it in a more virulent form —a feature which is the very essence of many Research Associations and industrial firms, resulting in or aiming at Mass Production. In consequence, individualism is not generally recognised resulting in necessarily killing craftsmanship. One of the chief aids to the development of individuality is indicated by *the impetus of acknowledgment and publication*. In order to encourage the workers in a team, it is quite essential to secure the publication of results under the names of the workers concerned which, many a time, is lost sight of by those above. By so doing, the individual worker feels confident, that he is capable of taking up other work, when the need arises for it.

How this capacity for the expression of the individual in a person can be detected, is a matter for serious consideration and is generally solved by

the persons concerned, in the light of their experience. It is, however, significantly true that neither our modern system of education nor the training in the post-graduate course, provides adequate ground for such recognition. According to Prof. Thorpe, the institution of Ph.D. degree in several universities, represents one way of overcoming the defects. This method may be open to question, particularly when we consider that many universities have abolished or are considering the abolition of this degree. It is claimed that the three qualities—self-reliance, patience and initiative, so necessary to work of merit—are evinced by an average worker for the above degree. Men of experience may have a different tale to tell. Another defect, inherent to the selection of the proper individual lies in the fact that different universities have different standards in science training. In the case of higher degrees the institution of qualifying examination by the Institute of Chemistry, is of great benefit to the research worker in the making. In this way, he becomes a "qualified" chemist.

Speaking about the system of research control by committees, it has been said that it is also the outcome of the war and has continued even to-day. Given wide breadth of view and strong human sympathy on the part of the persons composing the committee, it is one of the best methods of solving some urgent problem, but in wrong hands, it is highly susceptible of destroying personal initiative and individuality. Team-work in such cases demands that there should be free discussion among the members of the team. It is, however, rather unfortunate that the members cannot individually claim personal merit for any discovery or work of outstanding merit, while the results of such investigations form the property of the whole team. The snag, in such cases, is that the humble worker does not get adequate recognition for his work, which is rightly due to him. On the other hand, if members of a team do not exchange notes or discuss freely for fear that some one else might get the credit for what is originally his, the benefits of co-operative effort are completely lost. It is a happy sign that this attitude is fast dying out. In fine, team-work requires suppression of the self of its component parts, in the interest of the team, while those in charge of the investigation or the employers, should scrupulously avoid suppressing individualism of these parts. In the words of General Smuts, "The disappearance of the sturdy, independent-minded, freedom-loving individual and his replacement by a servile standard of mass-mentality is the greatest menace of our time."

These timely remarks coming from such an eminent authority, it is hoped, will not be lost sight of in the development of scientific and industrial research in this country, which is yet on its path to recognition in the scientific world.

"CHEMIST."

# Academies and Societies.

## Indian Academy of Sciences.

*April 1935.* SECTION A. T. S. SUBBARAYA: *Analysis of the Band Spectrum of Zinc.*—The analysis of $Hg_2$, $Cd_2$ and $Zn_2$ bands given by the author removes many of the difficulties inherent in the previous explanation that each one of the band series is a single $\nu'$ progression. C. N. SRINIVASIENGAR: *Singular Solutions of Simultaneous Ordinary Differential Equations.* I. CHOWLA: *Some Problems of Waring's Type.* S. CHOWLA: *A Theorem on Sums of Powers with Applications to the Additive Theory of Numbers.* S. CHOWLA: *A Theorem on Sums of Powers with Applications to the Additive Theory of Numbers II.* T. SURYANARAYANA MURTY: *Note on Dirichlet's L-Functions.* D. S. SUBBARAMAIYA: *On the Depolarisation of Tyndall Scattering in Colloids.*—The light incident on a system can be either unpolarised, or plane polarised with electric vector vertical, or plane polarised with electric vector horizontal. The inter-comparison of the corresponding values for depolarisation, $\rho u$, $\rho v$ and $\rho h$ furnishes important information regarding the size and anisotropy of shape or structure of the scattering particles. R. S. KRISHNAN: *On the Depolarisation of Tyndall Scattering in Colloids.*—On the assumption that the law of distribution in direction of the orientation scattering by larger particles is the same as that for very small ellipsoidal particles, the following simple numerical relationship $\rho u=(1+1/\rho h)/(1+1/\rho v)$ has been derived and found to be in satisfactory agreement with the observations reported in the previous paper. R. SAMUEL AND M. ZAKI-UD-DIN: *Note on the Absorption Spectrum of CaI.*—The end absorption in the ultra-violet is the only real absorption of CaI molecule. There are no bands present. S. K. BANERJI: *Theory of Microseisms.*—Microseisms of a definite type are produced by the disturbance of pressure at the bed of the sea produced by storm waves in the mid-Arabian Sea and mid-Bay of Bengal. A theory of these microseisms has been worked out by introducing into the usual hydrodynamical equations terms involving compressibility, and the amplified theory gives a satisfactory explanation of all the observed facts. Various other causes which might also produce microseisms are discussed. AKSHAYANANDA BOSE: *The Weiss Constant of Paramagnetic Ions in the S-State. Part II. Aqueous Solutions of Ferric Salts.*—The product $\chi T$ for aqueous solutions of ferric salts is appreciably less than the theoretical value. A study of these deviations, with respect to nature and concentration of salt, the acid content, and the temperature, indicates that the deviations might be due to the hydrolysis of the salts.

SECTION B. M. K. SUBRAMANIAM: *Preliminary Observations on the Effect of Fertilization on the Golgi bodies in the eggs of* Acentrogobius neilli (Gobius neilli, *Day*).—On fertilisation the golgi elements below the zona enlarge and the rim of the fatty yolk droplets break up into irregular granules; concurrent with these changes the inner portions of the zona become converted into a mucilaginous envelope, after the completion of which, the majority of the golgi are extruded. H. CHAUDHURI: *A Bacterial Disease of Wheat in the Punjab.*—By means of successful inoculation

experiments, it has been shown that the bacterial disease previously described by Hutchinson (1917), is caused by the bacteria *Ps. tritici* alone and that the presence of nematodes—*Tylenchus scandens* which were once suspected to play a part in the causation of the disease, is not necessary. P. MAHESHWARI: *Contributions to the Morphology of* Ephedra foliata, *Boiss. I. The development of the male and female gametophytes.*—A detailed account is given and forms the first of a series of papers concerning the complete life-history and anatomy of this species. A. SREENIVASAN: *Investigations on the Rôle of Silicon in Plant Nutrition. Part I. On the nature of interaction between soil and soluble silicates.*—The interaction between soil and silica, resulting in the retention of a large quantity by the soil (55-81 per cent.) is mainly due to adsorption. K. M. GUPTA: *A review of the Genus* Dipterocarpoxylon *of Holden with Description of a New Species* D. Holdeni: *from the Irrawady system of Burma.*—A review of the work on *Dipterocarpoxyla* since 1916 has been given. B. M. JOHRI: *The Gametophytes of* Berberis nepalensis *Spreng.*—From the morphological study, it is concluded that the *Berberidaceæ* shows a close relationship with the *Ranunculaceæ* and both should be included in the same group. A. RAMAKRISHNA REDDY: *The Structure, Mechanism and Development of the Gastric Armature in Stomatopoda with a Discussion as to its Evolution in Decapoda.*—An account of the structure and the *modus operandi* of the gastric armature of *Squilla nepa*, Latreille, in the light of the development of its oral and thoracic appendages, is given.

### Indian Chemical Society.

*February 1935.* N. R. DHAR, SANT PRASAD TANDON AND S. K. MUKHERJI: *Denitrification in Sunlight and its Retardation.* KALIPADA BASU AND RAMAKANTA CHAKRAVARTI: *Action of Dyestuffs and Narcotics on Proteolytic Enzymes—Trypsin and Papain.* G. V. JADHAV AND Y. I. RANGWALA: *Bromination of Substances containing two Aromatic Nuclei.—Part I. Bromination of Cresyl and Nitrophenyl Benzoates.* PRAFULLA CHANDRA RAY, HARIS CHANDRA GOSWAMI AND ANIL CHANDRA RAY: *On the Fluorination of Organic Compounds.—Part I.* NIL RATAN DHAR: *Chemical Aspects of Biological Oxidations.* P. G. DESAI AND A. M. PATEL: *Effect of Polarity on the Solubilities of Some Organic Acids.* B. K. CHATTERJEE AND B. L. VIASHYA: *The Reaction between Iodine and Oxalic Acids in Ethylene Glycol as a Solvent (A Preliminary Note).* DUHKHAHARAN CHAKRAVARTI: *Mercuration of Coumarins (A Note).* BIMAN BIHARI DAY, RUBI GUNDAY HARI RAMACHANDRA RAO AND TIRYVENKATA RAJENDRA SESHADRI: *Geometrical Inversion in Acids derived from Coumarins.*

*March 1935.* ABANI K. BHATTACHARYA: *Composition of Prussian and Turnbull's Blues, Part III.* N. R. DHAR, A. K. BHATTACHARYA AND B. L. MUKERJI: *Photochemical Reactions between Iodine and Oxalate.* GADIYARA GUNDU RAO: *The Dissociation Constant of Eugenol.* M. P. VENKATARAMA IYER: *Adsorption Indicator in the Volumetric Estimation of Sulphates.—A Colloido-Chemical Study.* PULIN BEHARI SARKAR: *The Chemistry of Jute-lignin. Part VI. Isolated Lignin and Lignin Native in Jute.* D. S. NARAYANAMURTI: *A Note on the Photochemical Reaction between Ethylene Iodide and Iodine in Carbon Tetrachloride Solution.* JNANENDRANATH MUKHERJEE, RAMPRASAD MITRA AND ANIL KUMAR BHATTACHARYYA: *On the Measurement of Absolute Rates of Migration of Ions by the Method of Moving Boundaries.* PRIYADARAJAN RAY AND DINES CHANDRA SEN: *Magnetic Susceptibilities of Cobaltic Salts and the Nature of the Cobaltic Ion.* S. P. GOVEL AND B. L. VAISHYA: *The Complex Formation between Manganese or Aluminium with Tartaric Acid in Alkaline Medium.* R. PADMANABHAN: *A Simple Apparatus for Fractional Solidification.* PARES CHANDRA BANERJEE: *Use of Vanadous Sulphate as a Reducing Agent. Part I.* M. B. RANE AND K. R. APTE: *Volumetric Estimation of Chlorides and Sulphates in a Mixture containing both with the help of Adsorption Indicator.*

## XII International Congress of Zoology.

THE XII International Congress of Zoology will be held in Lisbon on 15—21 September of this year, under the presidentship of Prof. Dr. A. Ricardo Jorge, Director of the Faculty of Sciences in the University of Lisbon. His Excellency the President of the Republic, Marshall Carmona and the Minister of Public Instruction are patrons of the Congress.

The sections of the Congress are the following: General Zoology, Experimental Embryology and Mechanism of the Development, Ecology, Zoogeography, Paleozoology, Comparative Anatomy, Comparative Physiology, Protistology, Entomology, Invertebrates, Vertebrates, Zootechnic, Bachiculture, Symbiosis and Parasitism, Nomenclature.

The Indian Universities have been officially invited to participate in the Congress and it is expected in the scientific centres in Portugal that an Indian delegation will be sent to Lisbon to represent the Indian Zoologists.

The social part of the Congress is most interesting; moreover the official dinners and receptions, a visit to the principal historical monuments of Portugal, a visit to the three University towns (Lisbon, Coimbra, Oporto) and a sea trip to the Archipelago of Azores and the Island of Madeira are included in the programme.

## Reviews.

MODERN SURVEYING FOR CIVIL ENGINEERS. By Harold Frank Birchal, O.B.E., D.F.C., ETC. (Chapman & Hall, Ltd., London). Pp. 524. Price 25*s*.

This book on surveying for Civil Engineers is the outcome of the author's experience in engineering surveys and is written with the purpose of placing in the hands of the engineer—specially the younger practitioner of the profession—a volume to enable him to get an insight into the practical side of surveying—that most valuable part of an engineer's work generally inadequately or not at all treated in most text-books.

The author presents the fundamental principles of surveying in a simple and clear style, eschewing almost rigorously all that he considers extraneous and superfluous matter. His treatment, though concise, is comprehensive and the great merit of the book consists in the lucid exposition of the methods of surveying as actually employed in connection with the several engineering projects. The young engineer, when faced with a problem, is sure to find a guidance in the pages of this book where detailed accounts of procedure adopted in solving similar problems encountered elsewhere in the past, are succinctly and lucidly given. The methods of estimating the cost of conducting surveys and determining the requirements under each head are other special features of this book.

The first eight chapters deal with the measurement of distances, accurate base line measurements for bridge location, methods of levelling, different types of levelling instruments, angular measurements by compass and theodolite, detailed descriptions of improved types of theodolites such as the micrometer and the *Wild* and *Tavistock* theodolites and Tacheometry including a discussion on the relative merits of the Jeffcott's Beaman's, Watts-Szepessy and Boss-Hardt Zeiss Reduction Tacheometers. The next three chapters deal with the methods of cross-sectioning, contouring, traversing and descriptions of the plane-table and the range-finder and methods of using them. The succeeding six chapters are mainly devoted to the methods adopted in connection with irrigation, pipe-line, water-supply, road and railway project-surveys including tidal-flow surveys for sewage disposal and tunnel-surveying. There is a chapter on circular and transition curves and another on railway Points and Crossings. The last two chapters deal with photographic and aerial surveying, just to give the reader the bare elements involved in such surveys and enable him to appreciate their applicability in specific cases, and localities, in preference to the ordinary ground methods.

The book is well-written and a large amount of new material, specially regarding recent improvements in surveying instruments, not to be found in many of the existing text-books, is included. Particular attention is called at all stages to the accuracy attainable in the different methods of surveying and the need for and methods of saving the needless labour and time generally spent on the attainment of the highest possible accuracy, whether necessary or not. The author's close association with surveying schemes is undoubtedly responsible for the many practical tips and the short and direct methods of approach to problems, that the book abounds in. There are numerous well-drawn diagrams besides several photographs of representative modern surveying instruments which will help the reader to follow the text with ease.

The aim of the author to place in the hands of the engineer a handbook of practical surveying, which will be of real help in solving field problems, is amply achieved and the book will be a very desirable addition to the reference library of an engineer.

D. SUBBA RAO.

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CELLULAR RESPIRATION. By Norman U. Meldrum. (Mathuen's monographs on biological subjects) 1933. Pp. xi+116. Mathuen & Co., Ltd., London. Price 3 *sh.* 6 *d.*

The book prepared by the late Dr. Meldrum sets forth in a simple manner and in a short compass the salient features of cellular respiration the literature on which is highly confusing, particularly for the beginner. The subject by itself forms a very important branch of biochemistry; in recent years, its importance has increased, as its ramifications have extended beyond simple 'respiration'. Thus oxidations and reductions play an important rôle in the activation of proteases; glutathione appears to function as a co-enzyme for glyoxalase, and is thus connected with carbohydrate metabolism.

Dr. Meldrum's treatment is logical and is easily understandable by the beginner. The

method of the book represents what may be described as "loud thinking". Its brevity has no doubt restricted its scope. The inclusion of a few essential experimental details would have greatly enhanced the value of the book; the 3-page appendix hardly serves the purpose. A few aspects of the subject could have been elaborated with advantage. Thus the close relationship and perhaps identity between the "Atmungs ferment" and "Indophenol oxidase" should have been emphasised. In the chapter on dehydrogenases, the products of oxidation of the metabolites could have been fully described. The chemical configuration of methylene blue has been needlessly repeated and in other respects too, such as in the arrangement of matter, the book is capable of improvement. There is no doubt, however, that the book forms an excellent introduction to the subject and even for the student requiring access to original literature a very useful list of selected references is given at the end of each chapter.

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HANDBOOK OF CHEMISTRY. Compiled and Edited by N. A. Lange. (Handbook Publishers, Inc. Sandusky, Ohio,) 1934. Pp. 1265 +249+29. Price $6·00.

This handbook compiled and edited by Dr. Lange will be welcomed by all chemists who require a reference volume containing "Chemical and physical data used in laboratory work and manufacturing." The list of contents comprise nearly 160 different sections compiled with specific attention to their utility for those interested in Chemistry and allied sciences. The comprehensive nature of the different sections can be appreciated when it is mentioned that under "Physical constants of organic compounds" there are 4452 entries with their Beilstein references. There can be little hesitation in saying that this book will prove indispensable to every worker having difficult access to a technical library.

The volume will find a place on the desk rather than on the book-shelf, as there is little doubt that the Chemist will find need to turn to its pages for frequent reference. By reason of the fact that the Editor has obtained valuable assistance and co-operation of a very large number of competent chemists in his arduous task, the handbook bears the stamp of an authoritative and reliable document. The get-up of the book with its flexible binding leaves nothing to be desired.

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STUDIES IN THE PHYSIOLOGY OF THE EYE. By J. G. Byrne. (Messrs. H. K. Lewis & Co.) Pp. 428. Price 40*s*.

"The title is somewhat misleading as the book is entirely devoted to certain limited aspects of ocular physiology and does not attempt to traverse the whole field of the subject usually termed "Physiology of the Eye". If the extent covered is small, the thoroughness with which the studies are made more than compensate what might appear at first a narrow field. Every chapter in the book bears ample evidence of numerous very careful and scientifically controlled Laboratory animal experiments from which conclusions have been drawn. The book is a valuable example of what good scientific reliable Laboratory work should be; for every batch of experiments are given the main purpose, the methods employed, experiments made, observations noted and conclusions drawn. Apparent discrepancies are not ignored but critically examined and where possible fully explained.

The book is divided into four parts. The first part deals with paradoxical pupillary phenomena following lesions of the affarent nerve paths. The author concludes that various somatic lesions and various visceral lesions produce an inequality of the pupils which fact considered in conjunction with somatic pain direct or referred will be of great value in diagnosis of disease and in medicolegal work. Part II deals with "Preliminary palpebral widening" with light stimulus and paradoxical palpebral and lens phenomena. Part III gives the results of stimulation of the sciatic nerve, the cervical sympathetic and VI cranial nerves and the observations made regarding palpebral widening or narrowing, proptosis or retraction of eye-ball and allied phenomena. Part IV deals with pupil constrictortonus and the mechanism of sleep, hibernation, Narcosis, Coma and related conditions. The rôle of the pupil constrictortonus in such pathological states as Argyll-Robertson pupil, anisocoria and miosis is dealt with. There is a critical discussion regarding the causation and the essential ingredients of the phenomenon of sleep in man and higher animals and conditions analogous to sleep in many lower animals as fish, frogs, reptiles and insects.

There is much that is rather unorthodox and thought-provoking in most of the chapters each of which has a rich Bibliography. The whole book is well illustrated and

provided with a good index. The work is of great value to Physiologists and Neurologists.

B. K. N.

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Structural Geology—with special reference to Economic Deposits. By Bohuslav Stoces and Charles Henry White. (Macmillan & Co., 1935). Price 25*s*. net.

This book is an elaboration of the work by Dr. Stoces on this subject (which has already been published in Czech and German) in collaboration with Mr. C. H. White, former Professor of Mining and Metallurgy at Harward University and now a consulting mining geologist with considerable experience in many parts of the United States and in several European countries. The book is primarily intended to meet the requirements of economic geologists and mining engineers engaged in the exploitation of mineral deposits. Being thus essentially a text-book of applied geology, special emphasis is naturally laid only on such aspects of structural geology as are necessary for those engaged in the successful exploitation and development of ore bodies. The first part of the book deals with the primary structures of rocks, both igneous and sedimentary, as distinguished from the induced or secondary structures in these rocks due to orogenic movements in the earth's crust, which have been elaborately described in the second part. At the end of each section a convenient summary of all the important conclusions has been given, often regularly tabulated, as for instance, in describing the damaging and beneficial effects of Faulting (pp. 246–260). Towards the end of the book there is just a small chapter of about 16 pages dealing with geophysical methods of prospecting, with special reference to those methods which have been successfully employed in recent years, based on such considerations as magnetism, gravity, rock elasticity, electrical conductivity, radioactivity, etc. The book is profusely illustrated with diagrams, sections and photographs (in fact, these make up nearly half the volume of the book) mostly taken from such standard works of continental authors as Schaffer's *Allgemeine Geologie*, Weinschenck's *Allgemeine Petrographie*, Rinne's *Gesteinskunde*, Heim's *Geologie der Schweiz*, etc.

There are just a few points, however, on which one feels inclined to comment after perusing the book. In some places, as for instance in the very first chapter on the Primary Structure and Arrangement of Sedimentary Rocks, the treatment of the subject-matter seems to be rather digressive; and although nothing has been said which is not useful, one feels that there is a certain amount of "rambling". The chapters on Joints and Veins might, probably with great advantage, have come before those on Folding and Faulting. This arrangement would also have secured the necessary continuity in thought between the chapters on Folding and Faulting and the next one on the "Principal Types of Structures in Folded and Faulted Regions". In dealing with the "nomenclature of faulting" (p. 180) the author says: "Since no system thus far proposed has had general acceptance we have, for the sake of simplicity and clearness, endeavoured to define precisely those terms in the use of which there has been lack of agreement." On going through the next few pages, we are not sure if the authors have succeeded in this endeavour to combine the three great virtues of simplicity, clearness and precision, in their own definitions.

Most of these points raised for comment and criticism may perhaps be considered as merely matters of opinion. Probably they are. In any case they do not seriously affect the value of the book which will be read with great profit by all those technical men who are interested in the development and exploitation of useful mineral deposits.

L. Rama Rau.

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Actualites Scientifiques et Industrielles. No. 199. Radioactivite Artificielle. By F. Joliot and Irène Curie. Paris, Hermann et Cie. 1935. Price 10 fr.

This monograph on the new and fast-developing field of "Artificial Radioactivity" by the original discoverers of new and artificially produced radioactive elements is a most opportune and authoritative exposition of the results so far obtained in this rich province of research. A full account of the fundamental experiments of the authors is given and then a brief discussion of the results of other observers. One could have wished for a more complete account of the results obtained by Fermi and his collaborators. Though the authors have been compelled to add a footnote that Fermi's claim concerning the production of elements beyond Uranium is disputed, the more recent work of Meitner seems to testify to the actuality of the production of elements 93 and 94. The

monograph hints at the immense possibilities that may materialise by the use of the artificially produced radio-elements in therapy and biological research. As a precursor in such a promising field, the present work will meet with a warm reception from all quarters. We must congratulate the Publishers on securing such timely and authoritative expositions of the most up-to-date results of modern research.

T. S. S.

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LE MOMENT ELECTRIQUE EN CHIMIE ET EN PHYSIQUE. GENERALITES ET METHODES. By J. Errera. (Hermann et Cie, Paris, 1935). Pp. 46. 14 Fr.

LE MOMENT ELECTRIQUE EN CHIMIE ET EN PHYSIQUE. MOMENT ELECTRIQUE ET STRUCTURE MOLECULAIRE. By J. Errera. (Hermann et Cie, Paris, 1935). Pp. 59. 15 Fr.

In these two monographs in the *Actualités Scientifiques et Industrielles* series the author has presented an extremely lucid and concise account of the present state of knowledge on the subject of dipole moments in chemistry and in physics. The first monograph is divided into three chapters, dealing respectively with a general account of polarisation and dispersion, methods of determining electric moments, and the theory of atomic bindings. This last chapter on homopolar and heteropolar bonds, valency angles, mobility of bonds and quantum resonance will be found to be particularly illuminating for many chemists not usually acquainted with the recent theories of molecular physics. The second monograph gives a neatly classified account of the informations gained regarding the structure of molecules, both organic and inorganic, from a study of their dipole moments.

The exposition is throughout supported by bold diagrams, clear tables, and a number of references to original papers. There is but one misprint, an obvious interchange between the moment values for nitro and nitroso benzene in table 8A, p. 17 of the second volume. In the midst of a number of books and monographs recently published on the subject of dipole moments, we have no hesitation in saying that these two *exposes* will be found useful both by physicists and by chemists.

M. A. G.

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DIFFRACTION DES RAYOUS CATHODIQUES PAR. By G. P. Thomson. (Hermann et Cie, Paris.)

This monograph is published as a part of *Actualités Scientifiques et Industrielles* in the section on theoretical physics under the direction of M. Louis de Broglie. It consists of translations in French of the first three papers on Electron Diffraction by G. P. Thomson published in the *Proceedings of the Royal Society*. The pioneer investigations dealt with in these papers are of historic value. They were the first experiments that were performed to demonstrate the wave nature of the electron. The diffraction of electrons now offers a powerful tool for the study of surface structure, the structure of free molecules and other topics. The above monograph on the pioneer investigations in these lines will be welcomed by workers in this field.

S. R.

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RECHERCHES SUR LES COMBINAISONS ENTRE LES SELS DE CALCIUM ET LES ALUMINATES DE CALCIUM. By J. Foret. (*Actualités Scientifiques et Industrielles*, 1935.)

The first 12 pages of this paper are devoted to a historical account of the subject and bring under review the existing knowledge about the various aluminates of calcium including those which contain sulfo and chloro groups.

The original investigations described in this paper establish the formation of two types of aluminates having the formulæ (I) and (II), when tricalcium aluminate reacts with soluble salts of calcium.

I. $3\,CaO.\ Al_2O_3.\ (A)_2Ca.\ 10\,H_2O$.

II. $3\,CaO.\ Al_2O_3.\ 3(A)_2Ca.\ 30\,H_2O$.,

where A represents Cl, Br, I, $(NO_3)$, or $(NO_2)$.

The characteristics of these compounds were studied with a microscope as well as by X-ray methods.

Adequate evidence is given to prove that tetracalcium aluminate is hexagonal, whereas tricalcium aluminate is cubic in structure.

The paper includes 4 excellent plates which show the Debye–Scherer diagrams and microphotographs of some of the compounds investigated.

K. R. K.

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HOST PLANT INDEX OF INDO-CEYLONESE COCCIDÆ. By S. Ramachandran and T. V. Ramakrishna Ayyar. (*Misc. Bull.* No. 4, Imp. Council Agr. Res., Delhi, 1934.) Price Rs. 1–10–0.

Its modest price and clear printing would give this publication a wide circulation both in India and outside it; but it is not comparable in quality with similar publications

in Europe and in America. The compilers show a lack of first-hand information with the insects mentioned and have not exhausted all the literature available. The names of plants are further arranged, at the end, in an alphabetical order while a similar index giving the names of insects would have been even more useful. In its absence it took us some time to realise that no new insect has been named by the compilers from Coimbatore nor by any worker from Pusa or Ranchi, three Indian centres, where so much work has been done on scale insects. The student of ecology would regret to find many plants not specifically mentioned and as such these items serve as mere decorations. For example, on the first page *Tachardina lobata* is mentioned attacking *Michelia champaca* and again another *Michelia* sp. which is highly improbable. At least the mistake regarding *Laccifer lacca* which is said to attack a *Schleichera* sp. besides *S. trijuga* could have been avoided by reference to the publications of Watt and of Glover, not mentioned in the bibliography, which would have added many more hosts to the list given in the publication under review. There are many such instances of double entry which only lead to confusion. *Laccifer mysorensis* is mentioned as found in India which would imply a wide range of distribution while as its name implies it is restricted to Mysore and the British districts adjoining it. *L. lacca* Kerr is stated also to attack *Shorea talura* which many a worker in Bangalore has shown not to be the case. *T. lobata* is supposed to have been named by Chamberlain. He spells his name as Chamberlin and Cockerell (*Psyche*, 1924, **31**, 47) has pointed out it should be credited to Green and Chamberlin has accepted it (*Bull. Ent. Res.*, 1925, **16**, 41). *Metacardia* is wrongly spelled at least in three places for *Metatachardia*. The name *Beesonia dipterocarpi*, Green (*Bull. Ent. Res.*, 1929, **19**, 205) is nowhere mentioned nor the bibliography gives Green's publications later than 1926–27, although the Bulletin was accepted for publication as late as 1932. *Inglisia chelonioides* is not cogeneric with *I. bivalvata*; the latter belongs to the genus *Cardiococcus* (*J. Bom. Nat. Hist. Soc.*, **28**, 4, 1034). *Lecanium colemani* Kann. is a very doubtful species questioned by Green and its non-existence, even in Bangalore, has already been shown. On p. 52 *T. Silvestrii* is given, without reference to any literature or locality, as attacking an *Ixora* sp. while its name is absent from the parasites of *Ixora coccinea*, a mistake which could have been easily avoided by consulting the necessary publication.

S. M.

* * *

REVIEW OF CURRENT LITERATURE RELATING TO PAINT, COLOUR AND VARNISH INDUSTRIES, Jan.-Feb. 1935. Pp. 82. (Research Association of British Paint, Colour and Varnish Manufacturers, Teddington.)

This 82-page volume introduces the reader to the rapid progress made in the various branches of paint, colour and varnish research and every progressive manufacturer in the trade will not fail to appreciate the importance of a review of this kind offered by the Research Association of British paint, colour and varnish manufacturers—a prosperous organisation which is rendering great services to the advancement of the paint industry in Great Britain. A particularly refreshing feature of the review is the importance given to shellac by devoting a special section to record the researches done on this important natural product now struggling to re-establish its pre-eminence. This review will be gratefully welcomed by every one interested either in research or manufacture of paints, colours or varnishes.

M. S.

* * *

LAC AND THE INDIAN LAC RESEARCH INSTITUTE. By Dorothy Norris, M.SC., F.I.C., P. M. Glover, B.SC., and R. W. Aldis, PH.D., D.I.C. (Criterion Printing Works, Calcutta, 1934). Pp. 53. Price Rs. 2–8–0.

The volume aims at giving those interested in the industry from whatever point of view, a concise and non-technical summary of the position when the Institute began its work, and of the results obtained of value to the industry during the last nine years of its activity. The brief summary of the Indian Lac Industry prefacing the volume refers to the pioneering entomological investigations of Tachard, Kerr, Carter, Stebbing, Imms and Chatterjee and Misra. It is unfortunate that there is no reference to the extensive entomological studies of Mahdihassan who was one of the first to establish the trivoltine character of a race of lac insects indigenous to the Mysore plateau. He has been the first to recognise the importance of various races of lac insects in relation to the quality of their lac secretion, a fact of great technical importance.

One wonders if the value of the publication would have suffered if attention had been called to the work of the Indian Institute of Science during the years 1917–1927, for a full period of 10 years during the time of Professors Fowler and Norris. It is difficult to deny that the foundations of biochemical and technological research on lac were laid at the Indian Institute of Science at Bangalore, and the circumstance that all the assistants in the physico-chemical and biochemical sections of the Namkum Institute are men trained at the Institute, bears ample testimony to this fact.

This unfortunate omission of a substantial portion of the recent work on the biochemical, entomological and technological aspects of lac carried out in a sister institution, lends a propagandist touch to the publication.

It would have been of some assistance to the interested public if a financial statement of the Institute were appended to the report. It is difficult to assess the value of fundamental research but where research is definitely meant to assist an industry, the public are taught to estimate the value of research in terms of the increased prosperity or stability which research may bring to the industry.

The revenue from the Lac cess levied by the Government of India amounts to nearly two lakhs a year and the aggregate amount spent on the founding and maintaining the Lac Research Institute at Namkum during the last 10 years, might now exceed twenty lakhs (precise figures are not available). The volume concludes with an impressive array of 88 publications issued from the Institute which we propose reviewing on a future occasion.

M. S.

* * *

REPORT ON THE SOAP INDUSTRY IN CEYLON. (BULLETIN NO. 1, COCOANUT RESEARCH SCHEME, CEYLON. By R. Child, F.I.C., B.Sc., Ph.D. (Lond.).)

This is the first of a series of bulletins issued by the board of management of the Cocoanut Research Scheme of Ceylon. As the Chairman points out in his introduction "This review of local raw materials that can be used in the manufacture of soap, of soap making process generally and of suggestions helpful to the local industry, comes at an opportune time and from one who has a knowledge of the technology of the industry."

The author commences his report with a critical and exhaustive examination of the various raw materials used for soap manufacture and proceeds to discuss the several soap-making processes now in vogue everywhere. An account of the chemistry of oils and fats is given in a manner, that should appeal itself even to the soap manufacturer who had not had the benefit of a systematic chemical training. Next a fairly detailed examination is made of the local raw materials available with special reference to the different varieties of cocoanut oil.

In discussing the different soap-making processes, the author dwells at length on the *Cold Process*, as the majority of soaps made in Ceylon at present are by this process according to him. Minute practical details are given and this should be of immense benefit particularly to the untrained soap maker. A brief account of the semi-boiled and settled processes of soap-making is also given.

In his recommendations, Dr. Child observes :—

"…. the local industry is quite capable of producing cheaply a reasonably good household soap in sufficient quantities. As an encouragement to develop a moderate increase in import duties would probably have good effect; ···The local industry is not in a position to compete in the toilet soap industry at present and 'prohibitive' increases in tariff are undesirable for that reason. An increase of 5 p.c. on all tariffs would not seem unreasonable ….."

Apart from this he suggests the establishment of a Government factory on the model of the Government Soap Factory, Bangalore, and a bureau of chemical advice. There is also a suggestion to control the quality of the soap by the Government by the issue of labels. These are recommendations worthy of serious consideration by the Government.

The report as a whole should commend itself to everyone engaged in the soap industry, directly or indirectly. The board of management of the Cocoanut Research Scheme deserves the thanks of the public for having decided to issue this valuable report gratis to all.

M. S. KRISHNA RAO.

## Erratum.

Vol. III, No. 10, p. 493, column 2, para 2, line 4,
For *Ophicephalus stolatus*, read '*Tropidonotus stolatus*'.

739-35.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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CONTENTS.





# The Indian Research Council.

THE appointment of the Marquis of Zetland as the Secretary of State for India may be used as an appropriate opportunity for reviving the question of the establishment of the National Council of Scientific Research. His Lordship, during his tenure of office as Governor of Bengal, evinced great solicitude in promoting the cultural advancement of this country, and in April 1933 he caused a circular letter to be issued to a select body of scientists and representative leaders of public opinion in India, offering assistance in case they should agree to co-operate with him in founding an Indian Academy of Sciences and Arts. It may be recalled that almost simultaneously, but independently, *Current Science* in its issue for May 1933 published an editorial in which cogent reasons were put forward for the institution of an Indian Academy of Sciences. Where His Lordship and this Journal contemplated a single authoritative institution, the movement initiated by them resulted in the inauguration of two scientific bodies, *viz.*, The Indian Academy of Sciences and the National Institute of Sciences. Both on grounds of finance and of expediency we deprecate plurality of institutions, and one of our co-operators wrote to us as follows on this subject :

> " The danger, of course, is that if we attempt to establish too many scientific bodies requiring support from Governments and Universities, we make it more difficult for existing institutions to continue : it must be remembered that at present we find it sufficiently difficult to obtain adequate support for the Indian Science Congress and for our journal—*Current Science.* "

The existence of multiple scientific bodies of the Academy status must make it increasingly difficult for the Central Government to recognise the claims of any one of these bodies as the official expositor of scientific opinion in India, and must definitely retard all proposals for the establishment of a National Advisory Board of Scientific Research. In this connection, our co-operator from whom we have already quoted, makes the following significant observation :

> " It so happens, however, that some three years ago, a committee of heads of scientific departments of the Government of India was called upon to advise

on the question of the formation of a National Research Council and of National Committees in India to adhere to and co-operate with the International Research Council and its Unions. We expressed the opinion that the formation of such a council was desirable although the conditions were not favourable for the institution of a National Research Council on lines analogous to those followed in most other countries for the reason that there was in India no body comparable to the Royal Society of London, the French Academy of Sciences, etc. The present position is that the project for the formation of a National Research Council in India is in abeyance for lack of funds; but ultimately when the financial situation improves and it becomes possible to consider again the formation of such a Research Council, it will be easier to form such a Council on lines analogous to those existing in other countries, if, in the meanwhile we have formed an Academy of Sciences in India of the nature projected in your (Editor's) circular."

At present we are confronted not so much with financial stringency as with a complicated situation such as few could have visualisedin May 1933, and we are afraid that if it is not promptly and wisely handled, it is capable of postponing indefinitely the establishment of a Research Council in India. For, it is obvious that all the four institutions which claim to occupy the status of an all-India character cannot fulfil the functions which only a strong Central Body can perform. The confidence which such an authoritative institution enjoys will be sufficiently high, as the Marquis of Zetland pointed out in his circular letter, "to consolidate and expand the intellectual interests within its own sphere of influence; while the standard which it maintains must necessarily provide example and inspiration for scientific work of the greatest significance; and the estimation, in which it is held by the International Associations should make its membership to be coveted as a distinction of meritorious and important scientific investigations."

Those who have been following the trend of modern scientific progress in this country must have noticed two distinctive features. The first characteristic is that a close and steady co-operation between different groups of investigators,—medical men, physicists, chemists, biologists and engineers,—is almost indispensable for an adequate solution of all social and economic problems. The second is that scientific discoveries in any one branch of science, whether theoretical or applied, find direct and ready application in apparently unrelated branches of knowledge. We have several research institutions in India equipped and maintained by Government subsidies, and it is obvious that investigations in them should proceed uninterrupted by the fluctuations of financial assistance and the inhibitions of departmental influences. There is therefore a great need for a central agency for the prevention of overlapping of effort and the duplication of expenditure of national revenues. It ought to be one of the functions of such an institution to secure the intimate co-operation of the medical, agricultural, industrial and forest research departments and stress the importance of a clearly defined policy of scientific investigations in these departments for the promotion of the national health and the economic efficiency of the country. It seems to us that the functions of the Research Council should not be restricted to the encouragement of co-ordination of research work alone, however important and necessary it may be for the intellectual advancement of the country. In a sense and perhaps for some time to come, this body must occupy the status and fulfil the functions of the Parliamentary Science Committee in Great Britain. It should seek opportunities for establishing a link between science and Government on the one hand, and on the other, between science and society. It ought to assume the responsibility of promoting discussions in the Council Chambers of Federal India, on scientific subjects in their application to economic policy and national well-being. It may even be necessary and desirable to arrange for occasional addresses by scientific authorities to the principal political parties of Legislative Assemblies and to assist the Government in all measures and acts which involve the application of modern scientific method. The usefulness and importance of the Research Council will, to a large extent, be tested not merely by the scientific prestige to which it might attain, but also by the measure of confidence which it induces in the Central Government on whose bounty it has to depend, and the extent of influence which it exerts on national affairs.

Such a conception of the functions of the representative scientific organisation was recently elaborated by our contemporary

'*Nature*,' and was also emphasised by Sir Mirza M. Ismail in his opening address at the inaugural ceremony of the Indian Academy of Sciences.

This is not, however, the first time that proposals for the formation of the National Council of Research have been put forward. At the first University Conference held in Simla in 1924, Sir C. V. Raman moved the adoption of a resolution for the establishment of a Central Advisory Board of Scientific Research, since the Board of Scientific Advice consisting mainly of the heads of various scientific departments which Government had brought into being was willingly permitted to become defunct in 1920. In September 1930, the Government of India addressed a letter to the Secretary to the Government of Bengal conveying their decision that India should join the International Research Council and its Unions (1) Geodesy and Geophysics, (2) Geography, (3) Astronomy, (4) Biological Sciences, and (5) Radio-Telegraphy, and further stated that provision was made in the budget of the Secretary of State for India for 1930–31 for subscriptions to these bodies. In the same letter Government pointed out that, as they were not aware of the existence of a representative scientific organisation to which adherence to the Council and its Unions could be entrusted, they had arranged for the time being to act as the representative of this country. The annual cost of India joining the Council and the five Unions, calculated on her population basis, is £548–13–4. The Inter-University Board at its conference in 1931 appointed a sub-committee to investigate and report on a scheme for the formation of an Advisory Board of Scientific Research. The Government of Bengal which consulted the Asiatic Society of Bengal on the subject of the letter of the Government of India dated September 1930, received in 1932 a memorandum embodying the considered views of that learned body; and other scientific institutions which were also consulted, submitted by that date their replies, generally favouring the establishment of a Research Council in India. It seems to us that the Indian Research Council when it is formed must be the only scientific organisation which by its representative character and prestige could be entrusted with the responsibility of adhering to the International Research Council and its Unions. It is not financial stringency that now stands in the way of creating this body so much as the confusion produced by the multiplicity of scientific institutions which within a year have come into existence. The Government of India were looking forward, as is manifest from their letter of September 1930, to the foundation of a strong and authoritative scientific organisation which would be willing and competent to advise them on the formation of the Indian Research Council. The position in 1935 is not more hopeful than it was in 1930 and so long as scientists in India permit the existing state of affairs to continue, the Government of India will also continue so long to remain in a state of perplexity. A definite movement should be initiated to remove the anomaly of four scientific bodies, each trying to function as an All-India organisation, and claiming to represent the national scientific interests. We could put forward a scheme for an All-India Organisation which would be thoroughly representative and satisfactory, if there were any indication that the conditions were propitious.

The value and usefulness of the proposed Indian Research Council must naturally depend not only on the readiness of the Government of India to utilise its services and to support it financially, but also on the willingness and preparedness of Indian Scientists to co-operate with one another, and with governments and their scientific departments. The spirit of exclusiveness and the provincial outlook, which unfortunately overtake scientific achievements only too often in India, must be fatal to the growth of public institutions and to the creation of expert scientific opinion, capable of influencing the policies and projects of Government. It is true that almost all the practical problems of administration involve scientific factors, and it is equally true that the absence of a representative organisation, which could provide Governments with a reasonably adequate unanimity of expert opinion on the control and administration of the life of the community, must account for much useless expenditure of public revenues. If the scientists would show any disposition to set their house in order and also their willingness to reach agreed settlement in matters relating to their departments, then the Government of India may be expected to appreciate the value and need of advice from those who by their foresight, character and capabilities acquire a right to be consulted. The one essential factor for the establishment of the

Indian Research Council is a modification of the existing policy, spirit and outlook of public scientific bodies, which must merge into a single representative organisation, so as to command the esteem and confidence of Governments, Universities and the general public.

The new Secretary of State for India who, as Governor of Bengal, had, more than any other administrator, evinced the greatest practical concern in the promotion of the cultural life of this country, and whose interest in the scientific progress of its people had never abated even in the midst of his other pre-occupations, may be expected to use his rare influence in establishing a right relationship between science and Indian administrative problems. Professor F. O. Bower once acknowledged that it was owing to the energy and enthusiasm of Lord Balfour that science was welcomed into the inner circle of Imperial Administration ; and India may confidently hope that the critical and constructive mind of the Marquis of Zetland may formulate a plan which would ensure a reasonable appreciation of the value of science in the administrative departments of the Government of India. We hope that an atmosphere favourable for initiating a movement for the establishment of the Indian Research Council will soon be produced by scientists in India who, by reason of their knowledge and capabilities, are entitled to exercise a greater control over such administrative problems of the country as fall within the range of scientific influence. These problems should no longer be permitted to be entrusted to the hands of those who have no first-hand knowledge of science, and the first step in this direction is to remove the reproach that India is practically the only civilised country without a National Research Council, to which the Government of India could look up for advice and guidance in all practical measures affecting the moral and material advancement of the people.

## The Educational Advisory Board.

IN 1923 the Government of India abolished the Bureau of Education as a measure of retrenchment and the Hartog Committee deplored this act of Government in order to save a few thousand rupees. When a few months back Sir G. S. Bajpai referred in the Legislative Assembly to the intention of Government to revive the Central Advisory Board of Education in accordance with the recommendation of the Committee, the Assembly suggested postponement of the proposals in view of the forthcoming reforms in the provincial and central administration. If the proposed Advisory Board is to fit into the general framework of federal administration, it is obvious that the Indian States should be adequately represented, for education, which is at the basis of all progress, must always remain as an all-India subject. The Hartog Committee points out that education as a provincial transferred subject has during the past fifteen years made little progress especially in the field of free and compulsory elementary education. The Simon Commission, of which the Committee was an auxiliary body, viewed the problem of education as one concerning the entire political and social destiny of the Indian Empire and the question of the extension of franchise and that of the reconstruction of rural life depend largely upon the amount of benefit which a carefully devised scheme of higher elementary education confers on the general Indian population.

The value and usefulness of the Board do not depend so much on its prestige as on the amount of expert knowledge, experience and industry which its members will ultimately bring to bear on the problems entrusted to them for investigation and advice. The existence of the Board consisting of eminent educationists and representatives of public opinion can be justified if Government recognises the need for advice and provides adequate funds for giving effect to its recommendations. Proposals for the rapid extension and improvement of the educational schemes in India are frequently made in the Legislative Chambers and Governments have frequently pleaded inability to accept the proposals of people's representatives on account of the limited provision they could make for education in their annual budget. The realisation that money spent on people's education is in the nature of public investment, must be the foundation of the financial policy of Government, whose first and last line of defence must at all times be a contented, prosperous and homogeneous population.

# The Quetta Earthquake.

THE disaster which has overwhelmed Quetta staggers imagination. Those who are situated far from the scene of this appalling catastrophe may not be able to comprehend the straits to which this frontier military station has been reduced by the earthquake. We have great praise for the military authorities for arranging efficient and prompt salvage and relief operations, and the splendid manner in which response is forthcoming to the Viceroy's appeal for funds is a witness to the profound and universal sympathy evoked by this holocaust. It is unofficially stated that there must be a death roll of 65,000 people.

Premonitions of the coming disaster were not wanting. Since the earthquake which convulsed Bihar last year, earth tremors were reported from various places and they were continually travelling westward. It is now well known that practically all Indian earthquakes have originated from the peripheral tracts of the Indo-Gangetic plain, at the foot of the great Himalayan mountain system. This belt of country is a zone of weakness and strain in the underground rocks, due to the severe folding and crumpling to which they have been subjected in the process of the elevation of the Himalayas. Now and again in some place or other along this belt, where the pressure exceeds a certain limit, the rocks readjust themselves and every such readjustment is accompanied by an earthquake of smaller or greater intensity.

The recent disaster which shattered Quetta is an example of such a tectonic earthquake. The underground geological structure of the rocks in the country affected by the upheaval is to a certain extent indicated by the nature and disposition of the hill ranges in the area. Geologists have pointed out that the several mountains of Baluchistan belong to the same system as the main mass of the Himalayas, and they really form a part of one great family of mountain chains. A glance at the physical map of Baluchistan shows that the Sulaiman range forms an important line of hills running north and south. At its southward end, the range takes a western bend forming the Bugti hills, and then it soon turns north-west giving rise to the Marri hills, extending along the Bolan pass to as far as Quetta. At this point there is a sharp hair-pin bend in the alignment of the hill ranges and we have, to the south of Quetta, the Brahui and the Kirthar mountains running due north and south. In a region of compression like the area covered by this plexus of hill ranges showing abrupt flexures and lying under severe strain, any increased stress must naturally result in a severe convulsion of the earth's surface. To the east of the present scene is the great Kachhi plain where an earthquake of great magnitude took place in 1909. The belt of the greatest havoc in the case of the recent earthquake runs roughly north and south extending over an area of about 70 miles long and 16 miles broad, including important and populous towns such as Quetta and Mastung. This will give us an idea of the epicentral area, where rocks of varying degrees of hardness and of different ages are known to occur, constituting the Baluchistan Mountain System. It is well known that "faulting" in rocks is the commonest type of movement which gives rise to earthquakes, and the probability is that it is a dislocation of this type that has been responsible for the Quetta Earthquake.

A more definite diagnosis of the cause of this earthquake must await a thorough and detailed geological investigation which has already been initiated by the Geological Survey of India.

Within recent times earthquakes have become an epidemic, and places like Quetta, one of the foremost R. A. F. base headquarters of the Western Command, where there must necessarily be large ammunition depots, need special protection.

# Transmutation of Elements and Induced Radio-Activity.

By T. S. Subbaraya, M.Sc., A.Inst.P.

THE alchemists of old had only dreamed of one artificial transmutation, *viz.*, that of the baser metals into gold. But modern Physics has witnessed wonderful transmutations far beyond the vision of the most visionary alchemist. The last year in particular has brought forth such a wealth of new and astounding results that to-day, we have already great difficulty in giving a resumé in a few pages. New discoveries are being published in ever-increasing numbers so that it behoves us to take stock of our position at frequent intervals. Such a survey is particularly needed at present and the following pages will be devoted to a brief account of the most important results so far obtained.

The first artificial transmutation was achieved by Rutherford in 1919 when he bombarded nitrogen by $\alpha$-particles and showed that hydrogen was produced. Blackett's cloud track photographs of this phenomenon showed that the $\alpha$-particle entered the nitrogen nucleus, ejecting a proton and forming an $O^{17}$ nucleus. The new missiles placed at the disposal of science by the discoveries of Cockcroft and Walton, Chadwick, Lawrence and Urey have rendered possible a large variety of transmutations. Our present purpose is not to discuss the results of all these experiments, but to pass on to a new discovery made by Curie and Joliot in the course of their researches in this field. We mean the production and study of new radioactive elements and the consequent enrichment of our knowledge of the nucleus. This new discovery is not only most important and interesting in itself but also because it has made it possible to produce chemical proofs of transmutation where previously one had to content oneself with considerations of the total charge and mass of the particles involved in the process and the conclusions deducible by such considerations.

The discovery of new radioactive elements was made by Curie and Joliot in the course of their investigations of the result of bombarding nuclei of the light elements by $\alpha$-particles from Polonium. The experiments of Rutherford and others had showed that most of the light nuclei up to Potassium emitted protons when bombarded by $\alpha$-rays, resulting in the formation of nuclei of other known elements. Now Cur[ie] and Joliot found that fluorine, sodium an[d] aluminium also emitted neutrons when th[ey] bombarded. Here therefore were new trans[-] mutations which could not however b[e] explained so easily as the previous typ[e]. Thus taking the case of aluminium, we hav[e] the following equation representing the trans[-] mutation by emission of protons :

$$^{27}_{13}\mathrm{Al} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{30}_{14}\mathrm{Si} + {}^{1}_{1}\mathrm{H} \quad .. \ (1$$

In these equations, the lower index repre[-] sents the charge on the nucleus and th[e] upper index gives its mass. The equatio[n] is such that the sums of the charges o[n] either side balance as also the sums of th[e] masses. Thus in the above equation, th[e] total charge on the left is $15 = 13 + 2$ and so also on the right the sum is $15 = 14 + 1$. Similarly the mass on the left is $27 + 4 = 3[1]$ while that on the right is equally $31 = 30 + 1$. The symbol $^{1}_{1}\mathrm{H}$ represents the proton tha[t] is ejected during the transformation. Whe[n] we try to set up a similar equation for th[e] transmutation observed by Curie and Jolio[t] in which neutrons were ejected, we are le[d] to the following :

$$^{27}_{13}\mathrm{Al} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{30}_{15}\mathrm{P} + {}^{1}_{0}n \quad .. \ (2$$

The symbol $^{1}_{0}n$ represents the ejected neu[-] tron of charge zero and mass one. Th[e] nucleus of Phosphorus of charge 15 and mas[s] 30 which we are thus led to postulate is on[e] which does not occur ordinarily in Natur[e]. Hence the difficulty involved in the abov[e] explanation. This very difficulty led t[o] important discoveries as we shall see below.

Now Curie and Joliot had alread[y] found[1] that some light elements like beryl[-] lium, boron and aluminium emit positron[s] when bombarded by $\alpha$-particles fro[m] Polonium. In the case of beryllium the[y] considered that the positrons were due to [a] materialization of the $\gamma$-rays emitted b[y] beryllium along with neutrons, thus :

$$^{9}_{4}\mathrm{Be} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{12}_{6}\mathrm{C} + {}^{1}_{0}n + \epsilon^{+} + \epsilon^{-} \quad .. \ (3$$

The symbols $\epsilon^{+}$ and $\epsilon^{-}$ represent the positiv[e] and negative electron respectively. Th[e]

1 *Comptes Rendus*, 1933, **196**, 1885.

view represented by equation (3) was supported by a comparison of the energies of the positrons emitted and of the $\gamma$-rays usually accompanying the emission of neutrons by beryllium. In the case of boron and aluminium, however, they found that the positrons had to be attributed to the product which resulted from the transmutation with the ejection of neutrons. The discovery of new radioactive elements and the explanation of (2) followed at once when Curie and Joliot found[2] that the emission of positrons continued even after they had removed the source of bombarding $\alpha$-rays, and that the activity, *i.e.*, rate of emission of positrons, followed an exponential law of decay as in the case of ordinary radioactivity. The explanation of (2) is now clear. We have seen that the transformation leading to the emission of neutrons necessitates the assumption of the formation of hitherto unknown nuclei such as $^{30}_{15}P$. If we now assume that these nuclei are ordinarily not found because they are unstable and that they disintegrate with the emission of positrons according to the ordinary law of radioactive decay, we have an explanation of the phenomena observed by Curie and Joliot. They also observed that the decay of each of the new nuclei produced by them had a characteristic half-value period. Thus in the case of aluminium, boron and magnesium, the half-value periods were respectively 3 mins. 15 secs., 14 mins., and 2 mins. 30 secs. The nuclear reaction as envisaged by Curie and Joliot in each of these cases is as follows:

$$^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{30}_{15}P + ^{1}_{0}n; \quad ^{30}_{15}P \rightarrow ^{30}_{14}Si + \epsilon^{+} \quad (4)$$

$$^{10}_{5}B + ^{4}_{2}He \rightarrow ^{13}_{7}N + ^{1}_{0}n; \quad ^{13}_{7}N \rightarrow ^{13}_{6}C + \epsilon^{+} \quad (5)$$

$$^{24}_{12}Mg + ^{4}_{2}He \rightarrow ^{27}_{14}Si + ^{1}_{0}n; \quad ^{27}_{14}Si \rightarrow ^{27}_{13}Al + \epsilon^{+} \quad (6)$$

The new radioactive elements thus produced were called radio-phosphorus, radio-nitrogen and radio-silicon respectively. Not content with a mere guess at the nature of the radioactive products thus formed, Curie and Joliot proceeded to establish their identity by chemical tests. This they were able to do, thanks to the radioactivity of the new elements. In all previous experiments on artificial transmutation, the chemical nature of the product could not be established because of the extremely minute quantity of the substance produced: in fact the product consisted of a small number of atoms and no chemical tests could be carried out on these. But the situation was now different; although the new radioactive products were also present in equally minute quantities, their radioactivity was there to serve as an indicator. Thus if the new products were precipitated by any chemical reaction, the fact of their having been so precipitated could be established by the circumstance that the radioactivity was now associated with the precipitate. In this way the chemical tests for phosphorus and nitrogen were applied and their formation in the processes represented by (4) and (5) was thus proved. Thus for the first time, new radioactive elements were produced and their nature securely established by chemical tests.

Other workers were not slow to pursue these investigations with various modifications. L. Meitner[3] studied the reactions occurring when aluminium was bombarded by $\alpha$-rays from Polonium and by means of Wilson cloud chamber photographs showed that aluminium is transformed in two ways as follows:

$$^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{30}_{14}Si + ^{1}_{1}H \quad .. \quad (1a)$$

and

$$^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{30}_{14}Si + ^{1}_{0}n + \epsilon^{+} \quad .. \quad (2a)$$

She also showed that the first of these reactions takes place about four times as frequently as the second. This fact that aluminium disintegrates in two ways was utilised by Curie and Joliot to arrive at an estimate of the mass of the Neutron. A comparison of the above equations shows that if the energies of the proton and of the neutron and positron appearing on the right-hand side of (1*a*) and (2*a*) respectively are known, an accurate estimate of the mass of the neutron becomes possible without the necessity of accurately knowing the masses of the other nuclei taking part in the reaction. Thus if $m_p$ and $m_{\epsilon^+}$ are the masses of the proton and positron respectively, and $W_p$, $W_n$, $W_{\epsilon^+}$, $W_R$ and $W_R'$, represent the kinetic energies of the proton, neutron, positron and the recoiling silicon nucleus in (1*a*) and (2*a*) respectively, the

[2] *Comptes Rendus*, 1934, **198**, 254 & 559.

[3] *Naturwiss.*, 1934, **22**, 172.

mass of the neutron

$$= m_p - m_{\epsilon+} + W_p - W_n - W_{\epsilon+} + W_R - W_{R'}.$$

The mass of the neutron was in this way found to be 1·0092. This is higher than Chadwick's original value 1·0067 and even his revised value, *viz.*, 1·0080 is less than the value thus deduced by Curie and Joliot. The question of the mass of these particles is important since it helps to throw light on the question as to which particle is elementary and which composite. Recently, Wentzel[4] has shown reasons to believe that the neutron may have a mass equal to that of the hydrogen atom; we shall, however, not linger over this topic here.

A comparison of equations (1*a*) and (2*a*) further shows that since in (1*a*) we have one particle of spin $\frac{1}{2}\frac{h}{2\pi}$ emitted while in (2*a*) there are two particles each with a spin of $\frac{1}{2}\frac{h}{2\pi}$, we have, in order to satisfy the conservation of angular momentum, to assume that in (1*a*) another particle of negligible energy, but with a spin of $\frac{1}{2}\frac{h}{2\pi}$ is emitted. This hypothetical particle has been called an anti-neutrino just as the similar particle assumed by Fermi to be emitted during $\beta$-transformations was called a neutrino. On de Broglie's theory a neutrino and an anti-neutrino together constitute a photon of light. These questions however cannot be elaborated here.

Ellis and Henderson[5] repeated the experiments of Curie and Joliot and confirmed their results. Cockroft, Gilbert and Walton[6] have employed artificially accelerated protons as missiles to produce new radioactive elements, while McHenderson, Livingston and Lawrence[7] and Crane and Lauritsen[8] have used artificially accelerated deutons and protons and produced other new radioactive bodies. A number of these emit positrons together with $\gamma$-rays due to their annihilation. Even more interesting is the work of Fermi[9] and his collaborators. Whereas the charged missiles such as protons, deutons and $\alpha$-particles employed by previous workers could be directed against light nuclei only since the greater charge on heavier nucle prevents these charged missiles from hittin the nucleus, Fermi hit upon the idea o employing neutrons to bombard variou nuclei. These neutrons, being uncharged can penetrate even the heaviest nuclei an systematic work by Fermi and his colla borators has resulted in the production o new radioactive elements from almost al the elements of the periodic table includin Uranium. In most of these cases, a $\beta$ activity with the emission of electrons i observed. In some cases, the neutron enter the struck nucleus forming a heavier isotop of the same. Apart from the regularitie which these authors have pointed out, grea interest attaches to their claim to hav produced elements of atomic numbers 9 and 94. In most cases, they have establishe the nature of the radioactive products b chemical methods, but in the case of el ments 93 and 94, their conclusions wer called in question by A. v. Grosse. The found that when Uranium is bombarded b neutrons, new radioactive products of hal value periods, 13 mins. and 100 mins. wer produced. Chemical tests were made t assure themselves that the new produc were not isotopes of known element Grosse[10] however came to the conclusio that the chemical reactions observed wi the new products were characteristic o element number 91 (Protactinium) and tha the reactions which were supposed by Fern to be opposed to such a conclusion were n conclusive at all. In view, however, of th importance of the claim put forward b Fermi, L. Meitner[11] has repeated their ex periments and by a new and decisive chem cal technique established beyond doubt tha the new bodies are not elements of atom number less than 92 and that the produ of period 13 mins. is most probably elemen No. 93; and since her experiments sho that the 100 mins. product is not an isoto of the 13 mins. product, the longer-live product must be element No. 94. Wheth the new elements beyond Uranium th proved to exist are similar to Rhenium an Osmium or whether they belong to family similar to the rare earths, is a questio which is awaiting solution.

The discovery of Curie and Joliot h thus led to important results which are su to increase our knowledge of nuclei an

[4] *Naturwiss.*, 1935, 23, 35.
[5] *Proc. Roy. Soc.*, A, 1934, **146**, 206.
[6] *Nature*, 1934, **133**, 328.
[7] *Phys. Rev.*, 1934, **45**, 428.
[8] *Phys. Rev.*, 1934, **45**, 431 and 497.
[9] *Proc. Roy. Soc.* A, 1934, **146**, 483.

[10] *Nature*, 1934, **134**, 773.
[11] *Naturwiss.*, 1935, 23, 37.

atoms; we must, however, before closing, refer to the practical utility of their discovery which Curie and Joliot have pointed out.[12] The new artificially produced radioactive elements and their radiations may in the near future displace the costly radium for therapeutic purposes, and minute traces of these radioactive bodies may be utilised as indicators in studying biological processes. Both of these happy ideas promise to produce lasting good to humanity and we may be confident that the important discoveries of Curie and Joliot will be followed up and lead to advances of vital importance in times shortly to come.

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## Baluchistan Earthquake of May 31, 1935.

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BARELY seventeen months have passed since the occurrence of the disastrous earthquake in Bihar and Nepal, and India is again sorely stricken by another calamitous earthquake in Baluchistan. The present note gives such preliminary information regarding the focal region and the intensity of the Baluchistan earthquake as can be gathered from the records of the Colaba Observatory alone.

Colaba Milne-Shaw seismograms of the Baluchistan earthquake are reproduced in Fig. 1 (N-S component) and Fig. 2 (E-W component). The preliminary and the

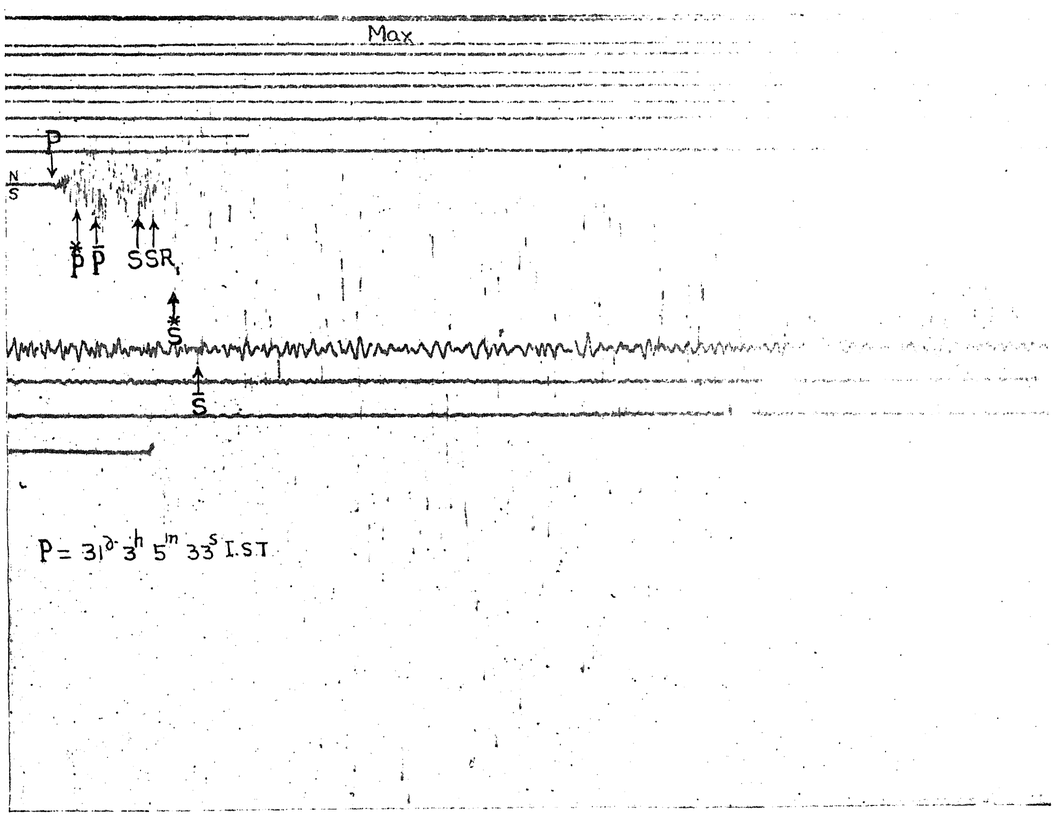


**Fig. 1.**
Colaba Seismogram of Baluchistan Earthquake, May 31, 1935. Milne-Shaw North-South.

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[12] *Radioactivité Artificielle,* Hermann et Cie, Paris, 1935.

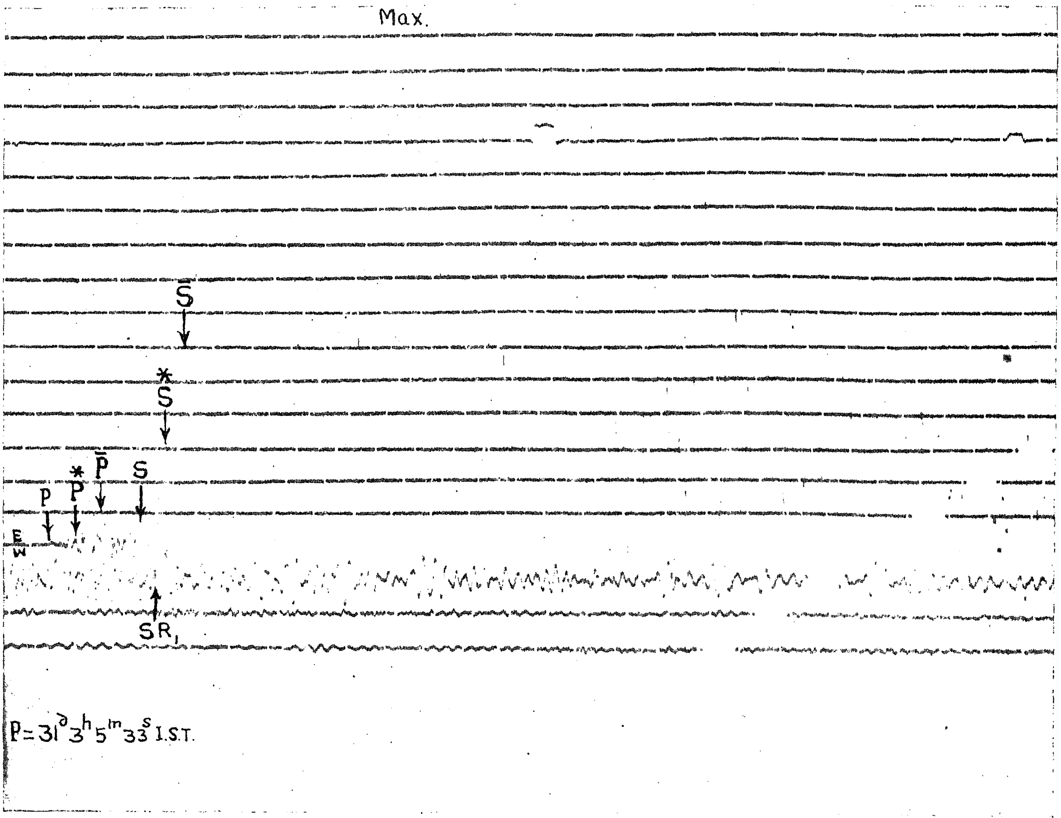


Fig. 2.

Colaba Seismogram of Baluchistan Earthquake, May 31, 1935. Milne-Shaw East-West.

secondary waves of shocks originating in the upper layer or crust of the earth travel to a near station in three distinct paths. The six phases P, $\overset{*}{P}$, $\overline{P}$, S, $\overset{*}{S}$ and $\overline{S}$ appear to be identifiable on the Colaba seismograms of the Baluchistan earthquake as in the case of the North Bihar earthquake.[1] The development of destructive surface waves also supports that the focal region of the Baluchistan shock was shallow in depth. An estimate of the actual depth can be made only when it is possible to scrutinise and study the records from other Indian seismic stations. The S-P interval at Colaba is 2 mts. 21 secs. giving an epicentral distance of about 1300 kms. The first preliminary tremors begin with an impetus of $5 \cdot 2\,\mu$ towards south and $2 \cdot 3\,\mu$ towards east giving the direction of the focal region as 333°. These data would locate the focal region of the earthquake roughly about 40 kilometers to the south of Quetta. The origin time of the shock is calculated to be 3 hrs. 2 mts. 43 secs I.S.T.

An estimate of the energy of the Baluchistan earthquake can be made from th Colaba seismic records by using a formul given by Dr. Harold Jeffreys.[2] While calculating the energy of the Pamir Earthquak of February 18, 1911, Dr. Jeffreys ha shown that the major part of the energy o an earthquake is carried by the Rayleig waves, the contribution from the longitudinal and the distortional waves being onl a few per cent. of the contribution by th long waves. Energy in a Rayleigh wave i the same as if there were no vertical motio and the horizontal motion had the sam amplitude as at the surface down to a dept $H = 1 \cdot 12\ \lambda$, where $\lambda$ is the wave-length The total energy crossing a small circle a distance $\Delta$ from the origin is

$$E = 8\pi^3 R \sin\Delta\,\rho \int \frac{a^2\,HV}{T^2}\,dt$$

[1] *Curr. Sci.*, May 1934, 2, 419; and Jan. 1935, 3, 298.

[2] *M. N. Geo.-Suppl.*, January 1929, 1, 22–31.

where $R$ = Radius of the earth.
$\Delta$ = Epicentral distance in degrees of arc.
$\rho$ = Density of the earth's crust.
$a$ = Amplitude of the earth's horizontal motion.
$T$ = Period of the long wave.
and $V$ = Velocity of propagation of long waves.

Now taking

$R = 6 \cdot 4 \times 10^8$ cms. ; $\rho = 3 \cdot 0$ gm./cm.$^3$
and $V = 3 \cdot 0 \times 10^5$ cm./sec.

we have

$$E = 4 \cdot 3 \times 10^{17} \sin\Delta \times \int \frac{a^2 H}{T^2} dt.$$

The average value of T at Colaba for the Baluchistan earthquake is about 12 s. and taking the average velocity of long waves as 3 km./sec. we find that $H = 4 \times 10^6$ cms. Also from the seismograms the value of $\int \frac{a^2\, dt}{T^2}$ is $0 \cdot 02$ cm.$^2$/sec. The energy of the Baluchistan earthquake thus works out to be about $7 \times 10^{21}$ ergs. The Colaba records of the North Bihar earthquake of January 15, 1934, were not satisfactory but a rough estimate for that shock gives the value of $\int \frac{a^2\, dt}{T^2}$ near about $0 \cdot 2$ cm$^2$./sec., leading to the approximate value of $7 \times 10^{22}$ ergs for its energy. Bihar earthquake was therefore about 10 times more energetic than the Baluchistan earthquake. This conclusion is also supported by the fact that the maximum amplitude of earth's motion at Colaba was greater than 1300 $\mu$ in the case of the Bihar earthquake while it is only about 400 $\mu$ for the Baluchistan shock. But the most unfortunate thing about the Baluchistan earthquake has been its occurrence during the early hours of the morning with consequent heavy death-roll.

# The Progress of Work in India on the Embryology of Angiosperms.

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INVESTIGATIONS on this subject started in this country only about fifteen years ago, but the number of annual contributions since then has been steadily increasing. The purpose of this article is to give a brief review of this work and to consider, if possible, some of the lines of research that may be most profitably undertaken in future by students of embryology in this country. Some judgment has been exercised in the selection of papers and a few investigations dealing with purely cytological studies have been left out, but otherwise the review is complete, and as far as the writer is aware, no important papers have been omitted.

The first observations of this kind were published from Allahabad by Kenoyer[1] (1919) who, while describing the dimorphic carpellate flowers in *Acalypha indica* L., noted the obturator, the beak-like tip of the nucellus and a few stages in the development of the embryo sac, which were, however, quite insufficient to permit definite conclusions.

Dastur[2] (1922) in an investigation of *Hydnora africana* Thumb., an interesting parasite, material of which had been collected from South Africa, writes that the ovules are orthotropous and have a single integument. The megaspore mother cell is hypodermal and directly gives rise to an 8-nucleate embryo sac of the Lilium-type. The most noteworthy fact is that the pro-embryo consists of a long chain of cells, of which the middle region gives rise to the embryo proper. These observations are of great interest, but it must be pointed out that the material was probably insufficient for a critical investigation and, as Schnarf[24] (1931) has pointed out, the statements need confirmation.

Tiwary[3] (1926), from Benares, made the interesting discovery of polyembryony in *Eugenia jambolana*, the extra embryos arising from the position of the egg apparatus or from the nucellus. It is also stated the original embryo sac sometimes becomes pressed out and obliterated, while some of the nucellar cells appear to be on their way to form embryo sacs. It may be mentioned here that recently Pijl[23] (1934) has published the results of a detailed study of polyembryony in several spp. of *Eugenia* and his observations differ in some respects from those of Tiwary.

Tiwary and Rao[4] (1934) have traced the development of the embryo sac in another member of the Myrtaceæ, *Callistemon linearis*,

which follows the normal course laid down for angiosperms.

From the same laboratory, Joshi[5] (1933) made a few observations on megaspore and embryo sac formation in *Argemone mexicana* L., and these were supplemented by Bose and Banerji.[4] The development is perfectly normal, but the antipodal cells attain a specially large size. Joshi's statement that endosperm formation may begin even before fertilisation needs more critical study.

Joshi and Raman Rao[7] (1934) made some very interesting observations on the embryology of *Tinospora cordifolia* Miers. The development of the embryo sac is quite normal, but there is no fertilisation and all the nuclei except the polars are said to degenerate. Endosperm formation continues, but no embryos could be seen even in mature seeds. These observations were immediately subjected to comments and criticisms (Sahni,[7] Tiwary[7]) and the presence of seeds with normal embryos has now been reported from Agra (Singh[7]), Bangalore (Seshagiriah[7]) and Ahmedabad (Ajrekar and Oza[7]). Cases of parthenocarpic fruits *are* on record and a condition as described by Joshi and Raman Rao is entirely possible, but as suggested by Singh it is more likely that in the present case the egg does not degenerate but develops parthenogenetically. Further observations on the embryogeny of this plant will be awaited with interest.

Joshi and Venkateswarlu[8] (1933) call attention to the peculiar behaviour of the synergids in *Ammania baccifera* L. The embryo sac develops in the usual way, but the synergids are persistent and begin to enlarge. Their nuclei divide amitotically, the lateral walls dissolve and the two cells fuse to form a "syn-synergid", which persists like a multi-nucleate collar round the suspensor of the growing embryo.

Naithani[9] (1933) from Allahabad, working on the life-nistory of *Digera arvensis* Forsk., found that the pollen grains are 3-nucleate at the time of shedding, and the megaspore mother cell gives rise to a row of 3 cells, of which the chalazal produces the embryo sac. A few months later Joshi and V. Rao[10] published a more detailed account of the same plant. The pollen grains are reported by them to be usually bi-nucleate and some variations have been recorded in megasporogenesis. It has been stated that 2, 3 or 4 megaspores may be formed and some other interpretations have also been offered, that are now shown to be incorrect by Puri and Singh.[11]

At Calcutta a large amount of work in this line is being done by Banerji and his students. Agharkar and Banerji[12] (1930) investigated the development of the embryo sac in *Carica papaya* and found that a normal linear tetrad is formed and as usual the chalazal megaspore gives rise to an octonucleate embryo sac with ephemeral antipodals. It must be pointed out that according to Heilborn* (1921, 1928) all the 4 megaspore nuclei (unseparated by walls) take part in the development and usually only one of them divides again, resulting in a 5-nucleate embryo sac. In view of the differences between these observations and those of previous authors like Kratzer* (1918) and Usteri* (1907), it seems profitable to reinvestigate the plant using material from as many different sources as possible. A feature which deserves further attention is the frequent formation of fruits even without male plants in the vicinity and the occasional presence of parthenocarpy.

Banerji's[13] work on the life-history of jute (*Corchorus olitorius* and *C. capsularis*) is a welcome addition to our knowledge of the Tiliaceæ. It is remarkable that even in an annual plant like this, growing in a tropical climate, the first division of the egg occurs 12–16 days after pollination. The same author has also studied the development of the female gametophyte of *Colocasia antiquorum* Schott.,[4] with a view to discover the causes of sterility in this plant. It was found that although degenerations start as early as the megaspore mother cell stage they are most common after the megaspores have been formed and sections of open flowers invariably show crumpled ovules without any embryo sacs.

Banerji and Bhaduri[14] (1933) have recorded the presence of false polyembryony in *Nicotiana plumbaginifolia* and also found some early stages of nucellar embryony in *Petunia* and *Withania*. Bhaduri[13] (1932) has given a detailed account of the life-history of *Solanum melongena* and another paper dealing with several other members of the family belonging to the genera *Solanum*, *Physalis*, *Withania*, *Datura*, *Cestrum*, *Nicotiana*, *Petunia*, *Salpiglossis* and *Brunfelsia*, is in the press. The same author has also observed an interesting peculiarity [first noticed by Miss Ferguson* (1927) in *Petunia*] in a tomato strain grown in the experimental grounds of the Calcutta University. It is

stated that the fusion nucleus divides, before the opening of the flower, to form a small micropylar and a large chalazal chamber. After the discharge of the pollen tube, one of the male nuclei fuses with the egg and the other with the endosperm nucleus in the micropylar chamber. This results in the formation of two types of endosperm cells, some with the triploid number (derived from the micropylar cell) and others with the diploid number (derived from the unfertilised chalazal cell).

From the same laboratory, Roy[15] (on *Pachyrhizus*, *Cajanus*, *Dolichos*, *Pisum* and *Lathyrus*), Datta[10] (on *Cassia tora*) and Pal† (on *Tamarindus indica*) have made valuable additions to our knowledge of the Leguminosæ. The statement that in all the plants mentioned above (except *Lathyrus*), no parietal cell is cut off and the archesporial cell differentiates in the third layer of the nucellus, needs more critical observation. It seems more likely that it is actually hypodermal as in the other members of the family, but becomes clearly distinguishable only after having cut off a wall cell and attained an appreciable increase in size (see remarks by Singh and Shivapuri[11], p. 429). S. Datta[5] has made some interesting observations on the embryogeny of two spp. of *Nolana*.

At Bangalore, Dr. M. A. Sampathkumaran has given a great impetus to such work. Rao[14] (1932) in a preliminary note on *Balanophora indica* states that the development of the embryo sac in this plant resembles *B. globosa* described by Lotsy* (1899). It must be mentioned here that very recently Ekambaram and Panje[11] from Madras have published their observations on a sp. of *Balanophora* collected from the Coorg-Malabar forests. Unlike other spp. of this genus, investigated by Treub* (1898) and Ernst* (1914), this one seems to have a normal sexual cycle with an embryo sac arising from the micropylar megaspore of a tetrad and with strong evidence of fertilisation. The female gametophyte is U-shaped with 4 nuclei in each end, but those destined to form the antipodals and the lower polar nucleus fuse among themselves to form a large irregular nucleus. The endosperm arises from the upper polar nucleus and the fertilised egg divides longitudinally.

Seshagiriah (1932[14], 1934[7]) has made some very interesting observations on the life-history of *Zeuxine sulcata* Lindley, a marsh orchid. Degenerations are found to be of frequent occurrence in the anthers and the second reduction division is entirely suppressed, resulting in the formation of "dyads of microspores". The nucleus in these cells divides to form the tube and generative nuclei, but the pollen grains soon degenerate. In some pollinia the heterotypic division was found to show certain abnormalities in the presence of several spindles which result in the formation of supernumerary nuclei, but none of these is functional. The megaspore mother cell undergoes the usual reduction divisions and forms a linear tetrad of megaspores. A peculiar feature is that all four cells of the tetrad directly function to form an embryo and additional embryos arise from divisions of some nucellar cells. In a friendly letter to the writer, the author states that an actual reduction of chromosomes is accomplished during the formation of megaspores and both nucellar and megasporic embryos persist in mature seeds.

From the same laboratory Narasimha Murthy[17] (1933), working on *Limnophyton obtusifolium* Miq., finds 3-nucleate pollen grains with two male cells, an 8-nucleate embryo sac developing according to the "Scilla-type" and a delayed triple fusion. The same author has also studied the life-history of *Ottelia alismoides*,[7] which is similar to other members of the Hydrocharitaceæ, except in having 2-nucleate pollen grains and a hypodermal archesporial cell which is said to function directly as the megaspore mother cell. Another feature of interest is that sometimes the microspores form linear tetrads in addition to the usual isobilateral type.

Rangasamy[10] (1934) has worked out the life-history of *Vallisneria spiralis*, but this investigation seems to have been carried out in ignorance of the previous studies of Burr* (1903) and Wylie* (1923) on this species.

Laksminarasimha Murthy[7] (1934) has studied the life-history of four members of the Commelinaceæ: *Cyanotis cristata*, *Cyanotis axillaris*, *Aneilema spiratum* and *Zebrina pendula*. The presence of needle-like crystals and mitotic divisions in the tapetal periplasmodium is of interest. After fertilisation, the narrow antipodal end of the embryo sac pierces deep down into the nucellus like a haustorium. The young embryo is merely a spherical mass of cells corresponding to the "Pistia-type" among monocotyledons.

Srinath[7] (1934) reports the usual type of embryo sac in *Herpestris monniera*, characterised by an absence of wall cells and the

formation of an integumentary tapetum, as is general among the Sympetalæ. The first division of the primary endosperm nucleus is followed by a transverse wall, separating the embryo sac into two chambers. The nucleus of the chalazal chamber divides only once and this part develops directly into a 2-nucleate chalazal haustorium. The micropylar chamber gives rise to all of the endosperm and a micropylar haustorium composed of four uni-nucleate lobes.

Kausik[7] (1935) has investigated the life-history of *Utricularia coerulea* L. The development is essentially similar to that described by Wylie and Yocom* (1923) in *U. vulgaris*. In both spp. the fertilised egg sends in a tubular prolongation, and the endosperm gives rise to both micropylar and chalazal haustoria, which take an active part in the absorption of food material.

The Rutaceæ is perhaps the first family in which polyembryony was discovered and Chakravarthy[7] (1935) has added *Murraya koenigi* to the list. The supernumerary embryos, which are derived from the adjoining nucellar cells, are usually distinguishable from the egg-embryo by the absence of a suspensor in the former. Most of them get arrested in their development and only 2 or 3 form cotyledons.

From Agra, a number of papers have been published by Maheshwari and his students. Johri[18] has investigated the life-history of *Limnophyton obtusifolium* and the chief difference between his results and those of Narasimha Murthy is that according to the former most of the embryo sacs are only 6-nucleate (the latter author found them to be 8-nucleate), as the two chalazal nuclei usually do not divide after the 4-nucleate stage. He has also reported a similar behaviour in *Sagittaria sagittifolia*,[11] *S. guayanensis*[11] and *S. latifolia*.[11] That the embryo sac of the Alismaceæ develops according to the Scilla-type and is as a rule only 6-nucleate, is also supported by the observations of Dahlgren (1928*, 1934[21]) on various other plants of the family. Johri[11] (1934) traced the development of the male and female gametophytes of *Cuscuta reflexa* Roxb. Peters'* (1908) statement on the absence of a middle layer in the anthers of *Cuscuta* is contradicted. The pollen grains were originally reported as 2-nucleate, but sections of older flowers recently cut for further study, reveal that the generative cell divides to form two male cells before the opening of the anther. The same author[11] has also studied the development of the gametophytes of *Berberis nepalensis* Spreng., and has called attention to the similarities between this family and the Ranunculaceæ. In another note, which is to be published shortly, he reports the presence of a 16-nucleate embryo sac in *Acalypha indica*, developing in essentially the same manner as was described by Miss Stephens* (1909) for the Peneaceæ, but several variations have been found with regard to the number of polar nuclei entering into the composition of the fusion nucleus.

Bhargava[13] (1932) published an account of the life-history of *Boerhaavia repanda*, which is essentially similar to *B. diffusa*, described earlier by Maheshwari.[16] The same author[11] has also studied the life-histories of *Mollugo nudicaulis* and *Trianthema monogyna*.† In both cases the development is normal, but in *Mollugo* the pollen grains were occasionally seen germinating *in situ*, and a third integument (hitherto unreported in the family) has been seen in the ovules of *Trianthema*. The same author has found that in *E. erecta*,[11] the tapetal cells form a periplasmodium and the pollen grains are 3-nucleate. The embryo sac develops normally, but there are sometimes only two antipodal cells, one of which is 2-nucleate. Later, the number of nuclei in the antipodal cells may increase, so that each is many-nucleate.

Puri[11] (1934) has reinvestigated the development of the embryo sac and embryo of *Moringa oleifera* and he finds that the previous observations of Rutgers,* recording the presence of a 5-nucleate embryo sac and free nuclear embryo in this plant, are unfounded. As a matter of fact, the embryo sac is of the usual 8-nucleate type and the first division of the egg is followed by wall formation as in other angiosperms. Occasionally the number of free nuclei in an embryo sac is more than eight, and some abnormal ovules with paired nucelli have also been seen. A feature of special interest is the presence of integumentary vascular bundles in the ovules.

Gupta[10] (1934) has described the development of the male and female gametophytes in *Potamogeton crispus*, and in another note, to be published shortly, he has reported some interesting variations in the life-history of *Wolffia arrhiza*.† Here the anther consists of only 2 loculi, parietal tissue is reduced to the endothecium and tapetum, and the pollen grains are 3-nucleate. The tapetal cells become amœboid and wander into the

anther loculus, while the epidermis disappears completely at maturity. The development of the embryo sac is of the Scilla-type and the antipodals and synergids are very ephemeral. The nucellus is absorbed at an early stage, except for a cap of cells which persists at the top.

Singh and Shivapuri[11] (1935) have studied the development of the gametophytes of *Neptunia oleracea* and Capoor[19] has done the same for *Ulmus integrifolia*. The latter has shown beyond any doubt that the embryo sac in *Ulmus* is of the normal type, arising from the chalazal megaspore of the tetrad. This necessitates a reinvestigation of *U. americana*, which is the only plant in the order Urticales, that has been reported to have a Lilium-type of embryo sac (Shattuck,* 1905).

Maheshwari[16] (1929) gave an account of the life-history of *Boerhaavia diffusa*. The pollen grains were originally reported to be 2-nucleate, but recently some 3-nucleate ones have also been seen. The ovule has a beak-shaped nucellus provided with a single integument, and the pollen tube travels down to the base of the funiculus and then turns into the tip of the nucellus. The number of antipodal cells increases to 6 or 7 after fertilisation (more recently, Bhargava has seen that in *B. repanda* this can happen even before fertilisation). The endosperm is free nuclear and the embryo is provided with a short but massive suspensor.

Maheshwari and Singh[6] (1930) found that in *Asphodelus tenuifolius* the embryo sac arises in the normal way, but a third integument begins to develop at an early stage, almost entirely enclosing the ovule after fertilisation. In a later communication, the first author reports that the endosperm is not free nuclear, but of the Helobiales-type. In another paper, the same author has described stages in the life-history of *Ophiopogon wallichianus*,[11] Hook. f., a member of the family Hæmoderaceæ. The life-history follows the normal course, but a primary wall cell may or may not be cut off in the ovules.

Maheshwari tried to find out the cause of the abortiveness of such a large number of flowers in *Albizzia lebbek*[20] and *Mangifera indica*[7] and found that in both cases it was due to widespread degenerations occurring at almost all stages in the anthers and ovules. The study of the life-history of the latter confirms the observations of Juliano and Cuevas[22] (1932), but the pollen grains are 3-nucleate at the time of shedding. The fertilised egg remains undivided for a long time—till about a thousand free nuclei have been formed in the endosperm.

Maheshwari and Gupta[7] (1934) have studied the development of the female gametophyte of *Ludwigia parviflora* and *Jussieua repens*. In both cases a linear tetrad of four megaspores is produced, but usually the micropylar functions. Sometimes the chalazal may also enlarge and occasionally some tetrads resembling an inverted "T" were seen in *Ludwigia*. The mature embryo sac is only 4-nucleate with an egg apparatus and a single polar nucleus. Sterility of the ovules was common and in *Ludwigia* several cases were encountered, where both nucellus and embryo sac had degenerated leaving only the integuments.

In a short note Maheshwari[4] has reported that in *Hydrilla verticillata* the anther-tapetum becomes amœboid, the pollen grains are 3-nucleate, the embryo sac is of the normal type, the endosperm of the Helobiales-type, and the embryo more or less resembling that of *Alisma*. Occasionally two paired nucelli were seen, each with its own inner integument, but enclosed within a common outer integument.

Maheshwari and Singh[7] (1934) have investigated the life-history of *Commelina benghalensis*, a common annual weed with white cleistogamous flowers developing underground and blue aerial flowers enclosed in a spathe. Of the three aerial flowers usually occurring in a spathe, one is male and two are hermaphrodite; of the latter, only one opens while the other is cleistogamous like the underground flowers. A true periplasmodium is present in the anthers and the presence of crystals of calcium oxalate in this is noteworthy. The nucellus forms a beak-shaped outgrowth, which comes up to the level of the micropyle. An important point is the presence of a normal tetrad of four megaspores, although it was previously considered that the development is of the Scilla-type (Guignard,* 1882, on *C. stricta*).

At Ajmer, Mathur[7] has been working, at the writer's suggestion, on the life-history of *Convolvulus arvensis*. The cutting off of a primary wall cell in the nucellus is a fact of interest, as there are very few cases in the Sympetalæ where the hypodermal archesporial cell does not directly function as the megaspore mother cell.

At Nagpur, Richaria[4] (1934) has been working on the development of the stamens in

several Asclepiads and it is reported that in spp. of *Hemidesmus*, *Cryptostegia* and *Cryptolepis* there are four sporangia in each stamen, while *Calotropis*, *Dæmia*, *Holostemma* and *Pergularia* have only two. In all cases except *Cryptostegia* and *Cryptolepis*, the microspores are arranged in the form of linear tetrads. In the last two genera, where the arrangement is tetrahedral, the pollinia are not well organised and form only a loose mass.

At Coimbatore, Dutt and Subba Rao[15] (1933) have investigated the development of the embryo sac and embryo of sugarcane. An abnormal case of an embryo sac with reversed polarity, pollen tubes with four male nuclei, and one case of polyembryony are recorded. In two cases it was seen that a few divisions had taken place in the egg, although the primary endosperm nucleus had not divided.

INVESTIGATIONS IN PROGRESS.

The above is a summary of what has been done, but several papers are in the press and many investigations are in progress.

At Benares, Tiwary is continuing his studies on the Myrtaceæ and has started additional work on the embryogeny of several Convolvulaceæ. Tiwary and Misra are studying the causes of sterility in *Hibiscus rosa-sinensis*, and Rao has almost completed his work on the embryo sacs of *Mærua* and *Antigonon*. Joshi and Venkateswarlu have completed their work on *Ammania baccifera*, and the first author is continuing further work on several plants of the Lythraceæ, Amaranthaceæ and Phytolaccaceæ.

At Calcutta, Banerji has completed his investigations on the embryology of *Arachis hypogea* and *Typhonium trilobatum*, and Samal has done the same for *Crotalaria juncea*. Das is working on *Trichosanthes dioica*; E. A. R. Banerjee on *Capsicum annuum*; Hedayetullah on some members of the Capparidaceæ; Datta on the Nymphæaceæ; Roy on *Aloe vera* and some Leguminosæ; and Bhaduri on several plants of the Solanaceæ.

At Agra, Capoor is working on the embryology of *Carica papaya*, *Urginea indica* and some members of the Urticales; Puri on *Anona squamosa* and *Moringa*; Bhargava on the Loranthaceæ and Capparidaceæ; Johri on the Euphorbiaceæ and Butomaceæ; Gupta on the Lemnaceæ; Singh on the Onagraceæ and Amaranthaceæ; and Maheshwari on *Hydrilla* and *Tamarix*.

At Nagpur, Nirula and Gadkari are working on the embryology of some Asclepiads and at Ajmer, Mathur has started some work on the life-history of *Vogelia indica*. In the South, Ekambaram and Panje are working on *Balanophora*, Raghavan on *Cleome*, Seshagiriah on the Orchidaceæ, Chakravarthy on the Rutaceæ, and Laksmi narasimha Murthy on some of the Commelinaceæ.

FUTURE OUTLOOK.

So far, the floral characters of angiosperm have been regarded as the most reliabl taxonomic guides. While this may b true, it is no longer possible to ignore othe factors. It is now being increasingly realise that an approach to a natural system o classification can be gained only by a stud of the plants in their entirety. It is danger ous for specialists to go on classifying an rearranging plants merely on the basis o one set of characters with which they ar most familiar. The crying need of the da is a classification, which also takes int consideration, embryology, wood anatomy and the vascular supply to the floral organs In future, any attempt, which does no take these factors into account, will b looked upon with half-heartedness.

A study of the existing literature reveal that among the families found in Indi there is a great dearth of information wit regard to the Menispermaceæ, Dilleniacea Bixaceæ, Flacourtiaceæ, Sapindaceæ, Diptero carpaceæ, Combretaceæ, Rhizophoracea Sonneratiaceæ, Alangiaceæ, Punicaceæ, Bom bacaceæ, Simarubaceæ, Sapotaceæ, Salva doraceæ, and others; while the Piperacea Santalaceæ, Loranthaceæ, Balanophoracea Fumariaceæ, Resedaceæ, Podostomacea Malpighiaceæ, Thymelaeaceæ, Elatinea Plumbaginaceæ and Pandanaceæ have yielde such exceptional results in the past, th further investigations on these would b welcome. Among special genera, whic deserve a fresh study, the following may b mentioned particularly: *Lemna*, *Costu Pandanus*, *Najas*, *Cypripedium*, *Typh Casuarina*, *Salix*, *Opuntia*, *Codiæum*, *Eupho bia*, *Garcinia* and *Zizyphus*.

There also remain a number of ou fruit trees and crop plants, which must b investigated both morphologically and cyto logically before the principles of scientif plant breeding can be applied to them wit confidence. It is true that most of thes plants will not yield results of such academ importance as those suggested above, bu they might lead on to discoveries from whic

the country may reap a benefit running into large sums of money.

Some real difficulties have for a long time formed a bar to rapid progress in this work. One of these is the difficulty of obtaining properly fixed material. At present a person who wants to do such work, has to limit himself to such plants which grow in his neighbourhood, although actually he is often interested in investigating as many representatives as possible of a special family or order, with which he has gained most familiarity. A second and more serious difficulty is the paucity of literature in this country. Much time is spent in searching for the necessary references and some authors actually engage themselves in such work without knowing what has already been done on the particular family or genus in which they are interested. Those, who know the literature and maintain some sort of a card index to keep in touch with current papers, find it difficult to procure the original references for study. The only way to avoid this difficulty is to encourage the exchange of reprints and journals among responsible workers. It is a pity that those persons, who are themselves favourably placed with regard to this matter, are often very conservative in lending literature and do not realise the difficulties of others, who have to fall back to a great extent on their private resources for purchasing reprints and journals.

In spite of these difficulties a good beginning has been made. Fortunately there are several enthusiastic workers in the country, several problems awaiting investigation are lying at our very doors, and in some cases even funds are available. Given the necessary facilities and encouragement, and a true recognition of their labours, the future is bound to be bright. Individually these investigations may seem trivial, but they all swell the fountain of knowledge and it is this accumulated information, which will help future workers to solve questions on which we can at present only indulge in guess-work.

In the end, I wish to express my sincere thanks to all those who co-operated with me in supplying the necessary information, and particularly to my pupil, Mr. H. R. Bhargava, who helped me in the preparation of the bibliography.

LITERATURE CITED.

1 *Jour. Ind. Bot. Soc.*, 1919, 1.
2 *Trans. Soc. South Africa*, 1922, 10.
3 *Jour. Ind. Bot. Soc.*, 1926, 5.
4 *Curr. Sci.*, 1933–34, 2.
5 *Jour. Ind. Bot. Soc.*, 1933, 12.
6 *Jour. Ind. Bot. Soc.*, 1930, 9.
7 *Curr. Sci.*, 1934–1935, 3.
8 *Nature*, 1933, 132.
9 *Bull. U.P. Acad. Sci.*, 1933, 3.
10 *Jour. Ind. Bot. Soc.*, 1934, 13.
11 *Proc. Ind. Acad. Sci.*, Ser. B., 1934–1935, 1.
12 *Jour. Dept. Sci. Calcutta Univ.*, 1930.
13 *Jour. Ind. Bot. Soc.*, 1932, 11.
14 *Curr. Sci.*, 1932–33, 1.
15 *Ind. Jour. Agri. Res.*, 1933, 3.
16 *Jour. Ind. Bot. Soc.*, 1929, 8.
17 *Mysore Univ. Jour.*, 1933, 7.
18 *Jour. Ind. Bot. Soc.*, 1935, 14.
19 *M.Sc. Thesis* 1935, Agra Univ. (unpubl.).
20 *Jour. Ind. Bot. Soc.*, 1931, 10.

OTHER LITERATURE.

21 Dahlgren, *Planta, Archiv. f. Wiss. Bot.*, 1934, 21.
22 Juliano and Cuevas, *Philippine Agri.*, 1932, 21.
23 Pijl, *Rec. Trav. Bot. Néerlandais*, 1934, 31.
24 Schnarf, *Vergleichende Embryologie der Angiospermen*, 1931.

* For full citation see 24.
† In the press.

## Chronica Botanica.

WE have pleasure to announce the publication of the first Volume of *Chronica Botanica*, a new international year-book, devoted to all branches of Plant Science, edited by Dr. Fr. Verdroon in collaboration with an Advisory Board and numerous Assistant and corresponding Editors. Plant Science has a new annual such as never before existed in any branch of Science. Prof. E. D. Merrill, Director, New York Botanical Garden, writes, "The *Chronica Botanica* as conceived covers a new field not hitherto pre-empted, conflicts with no established periodical, supplements those already in existence and should, by its very nature, encourage the spirit of international co-operation, a spirit characteristic of this, our science of which we as botanists representing all nations, are individually and collectively proud." This new publication will help all research workers interested in botany to keep in touch with the activities of the numerous Institutions, devoted to pure and applied botany. We have no doubt that the publication, so comprehensive and so useful, will be welcomed by everyone interested in Plant Science.

# The Banded Ferruginous Quartzites of the Bababudan Hills, Mysore State.

By Charles S. Pichamuthu, B.Sc., F.G.S., F.R.S.E.,
*Assistant Professor of Geology, University of Mysore.*

ONE of the chief arguments for considering the banded ferruginous quartzites of the Bababudan Hills of Mysore, as being derived from the alteration of basic igneous rocks, has been founded on the occurrence of thin intercalated bands of schists, which have been variously described in the *Records of the Mysore Geological Department* as "hornblendic beds," "riebeckite and cummingtonite schists," "amphibolites," "hornblendic traps," and so on.

According to Dr. W. F. Smeeth,[1] "the hornblendic beds which are of the nature of amphibolites appear to alter gradually into quartz-iron ore rocks, and this is more noticeably the case where such amphibolites consist largely of the mineral cummingtonite" (1908, p. 21).

The late Prof. P. Sampat Iyengar[2] considered the magnetite quartzites as derived from the alteration of riebeckite and cummingtonite schists. The thin quartz layers of the rock appeared to him to be "partly secondary enrichment in the schists at the expense of the cummingtonite, and partly the result of intrusion in the schists, of several thin quartz veins" (1908, p. 73). He explained the fine banding of the quartzites as the consequence of *lit-par-lit* injections of quartz veins in the amphibolites, the regularity of the banding being augmented by subsequent pressure which acted upon the whole mass of the schists (1908, p. 76).

H. K. Slater[3] was of the opinion that the banded magnetite hematite quartzites were produced "through the metamorphism and oxidation of the bands of amphibole, which vary from one inch to three feet in thickness, that form the aphanitic greenstones" (1908, p. 56).

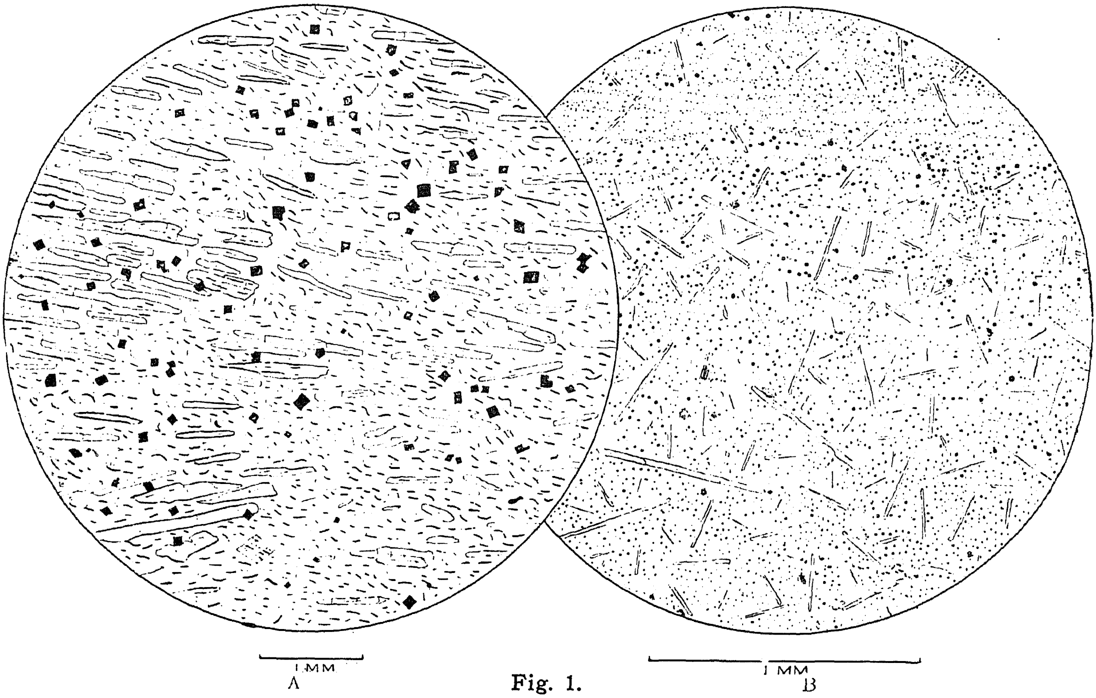


**Fig. 1.**

A. Micrograph of bababudanite-magnetite schist.
B. Micrograph of hornfels with decussate structure. The section shows the banded nature of the rock.

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[1] Smeeth, W. F., "General Report of the work of the Department for the year 1907–8," *Rec. Mys. Geol. Dept.*, 1908, 9.

[2] Sampat Iyengar, P., "Geology of parts of Hassan and Kadur Districts, Mysore Province," *Rec. Mys. Geol. Dept.*, 1908, 9.

[3] Slater, H. K., "Report on the Geological Survey of a portion of the Kadur District," *Rec. Mys. Geol. Dept.*, 1908, 9.

B. Jayaram[4] thought that the iron ore formation had little to do with the "alteration, silicification and ferruginitisation of the older hornblendic or later hornblendic traps that are underlying the above formation" (1923, p. 40). He did not, however, offer any suggestions as to the probable mode of origin of these rocks.

I have recently examined these intercalated schists both in the field and in the laboratory, and find myself unable to agree with the views advanced by Smeeth and Sampat Iyengar. These schists are often only a few inches in thickness, and are impersistent. Examples of bababudanite schists can be seen on the road sections between the 28th and 29th miles on the Chikmagalur-Lingadhalli road. They are crowded with glistening crystals of the amphibole. The microsections (*vide* Fig. 1A) show a felted or banded aggregate of acicular crystals of bababudanite which exhibit a very beautiful pleochroism from yellow to violet to blue. The matrix is formed of granoblastic quartz. So abundant are the crystals of magnetite scattered through the rock, that it is preferable to designate it as bababudanite-magnetite schist. The above description would make it clear that these schists bear no resemblance either texturally or mineralogically to the epidiorites which occur as dykes and lava flows in the area.

In order to elucidate more definitely the nature of this rock, a chemical analysis was made of a specimen of the bababudanite-magnetite schist occurring near Kemman-

| | I | A | B | C | D | P | Q |
|---|---|---|---|---|---|---|---|
| Fe | 34·3 | 37·8 | 36·6 | 41·1 | 34·5 | 35·2 | 36·4 |
| $SiO_2$ | 44·15 | 39·17 | 42·90 | 33·89 | 46·25 | 38·80 | 37·28 |
| $Al_2O_3$ | 0·25 | 1·14 | .. | 1·15 | 0·92 | 0·20 | 0·40 |
| $Fe_2O_3$ | 40·20 | 40·42 | 34·77 | 49·43 | 30·62 | | |
| $FeO$ | 7·98 | 12·33 | 15·82 | 8·46 | 16·92 | | |
| $MgO$ | 3·11 | 1·90 | 2·62 | 2·40 | 2·13 | 4·32 | 2·46 |
| $CaO$ | tr | 1·37 | 1·33 | 3·16 | 1·69 | 2·55 | 2·35 |
| $Na_2O$ | 2·60 | .. | .. | .. | .. | .. | |
| $K_2O$ | tr | .. | .. | .. | .. | .. | |
| $H_2O^+$ | 0·05 | 2·56 | 0·47 | 1·50 | 0·42 | | |
| $H_2O^-$ | 1·60 | | | | | | |
| $TiO_2$ | tr | .. | .. | .. | .. | | |
| $P_2O_5$ | tr | tr | tr | .. | 0·07 | | 0·05 |
| $MnO$ | .. | 0·55 | 1·73 | 0·34 | 1·01 | | |
| $CO_2$ | .. | .. | .. | .. | .. | | |
| | 99·94 | 99·44 | 99·64 | 100·33 | 100·03 | | |

I. Bababudanite-magnetite schist, Bababudan Hills, Mysore. Analyst: W. H. Herdsman, Glasgow.

A, B and C. Magnetitic slates, Wisconsin (Irving & Van Hise,[5] 1892, p. 197).

D. Grünerite-magnetite schist, Michigan. Analyst: H. M Stokes. (Van Hise, Bayley & Smyth,[6] 1897, p. 338).

P. Iron ore-amphibole rock. Badampahar Iron Mines, Noamundi, Singhbum District, India. (Percival,[7] 1931, p. 199).

Q. Actinolite bearing recrystallised banded hematite silica rock, Badampahar. (Percival, 1931, p. 224).

gundi. The results are given under column I in the above table. A–D are analyses of amphibole magnetite rocks occurring as intercalations in the Lake Superior banded ironstones of Michigan and Wisconsin, and which are considered to be of sedimentary origin. It will be seen that the Mysore rock compares very well with these analyses. P and Q are partial analyses of somewhat similar amphibole bearing rocks from the Singhbum District, India. In these two analyses, only the percentage of metallic iron has been determined, and so, to facilitate comparison, the percentages of metallic iron in the other analyses have been calculated.

It will be seen from the above analyses that the Mysore rock contains 3·11% of MgO as against a trace of CaO. The dominance of magnesia over lime is suggestive of a sedimentary origin. Van Hise and Leith[8] considered that the Lake Superior iron bearing formations must have been chemically precipitated because the average proportion of magnesia to lime is over 5 to 1 (1911, p. 506). A similar calcium-magnesium ratio has been observed in the Noamundi area by Dr. Percival (1931, p. 200), who is of opinion that these banded iron ores have originated as chemical sediments. The dominance of ferric over ferrous iron noticed in the bababudanite-magnetite schist, when considered in conjunction with the magnesia-lime ratio, strengthens the view that these rocks must have had a sedimentary origin.

A striking difference which the analysis

[4] Jayaram, B., "Progress Report on work done during the field season of 1919–20," *Rec. Mys. Geol. Dept.*, 1923, 20.

[5] Irving, R. D., and Van Hise, C. R., "The Penokee Iron-bearing Series of Michigan and Wisconsin," *Mon. U.S. Geol. Surv.*, 1892, 19.

[6] Van Hise, C. R., Bayley, W. S., and Smyth, H. L., "The Marquette Iron-bearing District of Michigan," *Mon. U.S. Geol. Surv.*, 1897, 28.

[7] Percival, F. G., "The Iron Ores of Noamundi," *Trans. Min. Geol. Inst. India*, 1931, 26.

[8] Van Hise, C. R., and Leith, C. K., "The Geology of the Lake Superior Region," *Mon. U.S. Geol. Surv.*, 1911, 52.

of the Mysore schist exhibits, is in the presence of 2·60% of $Na_2O$. The igneous rocks adjoining and underlying the banded ferruginous quartzites of the Bababudan Hills, are many of them rich in soda, as may be seen from the prevalence of albite and acid oligoclase. I ascribe the soda content of the bababudanite-magnetite schist to the sediments being derived from these spilitic rocks.

Jayaram looked upon bababudanite as a "secondary metamorphic mineral derived from the alteration of impure grits and tuffs of the Champion gneiss series" (1923, p. 40). This is followed on the next page, by the statement, "the occurrence of this amphibole seems to be precisely comparable to that of tourmaline in the altered acidic rocks of the Champion gneiss series," which makes it rather difficult to understand his view regarding the origin of this amphibole.

In a previous note in this journal[9] (Pichamuthu, C. S., and Srinivasa Rao, M. R., 1933, pp. 276–77), it was shown that the amphiboles occurring in the banded magnetite quartzites of the Bababudan Hills were formed by contact metamorphic action due to the intrusive epidiorite dykes, and had nothing to do with the origin of the ironstones themselves. I consider the bababudanite-magnetite schists also to have had a similar origin.

In view of the suggestion made by Slater, that the banded ferruginous quartzites have been produced through the metamorphism of layers of a rock described by him as "aphanitic greenstone," I carefully examined the occurrences of this rock, not only from his type area near the 23rd milestone on the Chikmagalur-Lingadhalli road, but from several other exposures in the road sections between Mulaingiri (△ 6310) and Kondekhan (13° 33′ : 75° 46′). These are usually very thin intercalations, often exhibiting extraordinarily fine bandings. The rock is dark in colour and mixed with abundant ferruginous dust. When altered, it is converted into a yellow ochreous material. There is practically no grit. The exposures of this rock near the Kondekhan coffee estate house are highly jointed, the joint faces being very smooth. The specific gravity of specimens collected here is 2·65; in other parts of the Bababudan Hills, I have observed a range in specific gravity between 2·51 and 2·75. Sections cut from this rock do not exhibit any igneous character. The rock could best be described as a mudstone or argillite.

The rock is normally soft but has been hornfelsed near igneous contacts, with the result that it has become extremely compact and tough, the fracture suggesting a glassy rock. This is caused by the development of mica or amphibole with the typical decussate structure characteristic of a hornfels (*vide* Fig. 1B).

From what has been said above, it will be seen that the amphibole-magnetite schists of the Bababudan Hills have developed in certain bands as the result of contact metamorphism, and that they do not represent remnants of the parent rock from which the banded ferruginous quartzites have originated. The "aphanitic greenstones" of Slater are merely interbanded argillitic layers which have become hornfelsed near igneous intrusives.

[9] Pichamuthu, C. S., and Srinivasa Rao, M. R., "Amphiboles in the Bababudan Iron Ore Rocks," *Current Science*, 1933, 1.

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## Madras Fisheries Department.

RECORD of another year's good work is contained in the Administration Report of the Madras Fisheries Department for the year 1933–34.

"The outstanding event of the year which has brought back some measure of prosperity to the fishing industry of the West Coast was the return of the oil sardine in unexpected abundance after an absence almost complete for an unusually long series of years." It is unfortunate, however, that maximum advantage could not be taken of the abundance of fish owing to the prevailing economic depression. Attention may here be directed to an observation made by the Director (p. 22): "When the sardines became rich in oil, and boat loads were available at a nominal price, the station had run out of funds. When the funds were actually sanctioned, the sardines had ceased to occur and the amount had to lapse." It shows that the Government methods in dealing with economic problems require revision and it seems desirable that there should be a special provision in the departmental budget which could be drawn upon only in cases of emergency.

The oil sardine is unquestionably the

most important economic fish of the West Coast and any efforts made to study its migratory habits and to forecast its relative abundance year by year will no doubt help to ameliorate the condition of the fishing industry permanently. In Western countries years of observations and experiments have yielded valuable data regarding the wanderings of the principal food-fishes and it is gratifying to learn that similar observations were made during the year by the Madras Fisheries Department with regard to oil sardines to elucidate the causes responsible for the abundance of the species during 1933. At present the data collected may not give any clue to the solution of the problem, but series of such observations carried over a number of years are bound to prove useful. The feeding and breeding habits of the oil sardine and the hydrographical data of the areas of their occurrence are likely to yield interesting results. The abundance of the species along the Malabar Coast shows that it prefers waters of fairly high salinity and their time of occurrence is such--August to December, period of maximum abundance in 1933 being last week of October—that there is usually a considerable change in the coastal fauna of India due to the lowering of the salinity in certain areas on account of the monsoon rains.

*Hilsa* is another migratory fish of great economic importance and the Madras Fisheries Department has been carrying out investigations regarding its artificial culture and life-history. Regular observations in the field have revealed that in the Godavari below the Dowlaishweram *Hilsa* of varying sizes are present throughout the year. The Director observes that "At any rate the important fact that young *Hilsa* up to $8\frac{1}{4}$ inches reside in the lower reaches of the river and do not go to the sea seems fairly well established." The publication of the full results of these investigations will be watched with considerable interest by Bengal and Sind where there is an extensive fishery of this species.

The migratory habits of *Hilsa* seem to be associated with the lowering of the salinity of the sea water on account of heavy rains. The abundance of the species along the East Coast and its absence along the West Coast also point to the same conclusion. The Department's efforts to introduce *Hilsa* along the West Coast are not likely to meet with success as there are no large rivers in that area for the fish to run up for spawning purposes.

*Catla*, a tank-fish of northern India, has been successfully introduced in the Madras Presidency where it flourishes in reservoirs, tanks, and in the lower reaches of the Cauvery. It is doubtful, however, whether any good can result from the stocking of the upper waters of the Cauvery because the fish is not adapted to live in clear, rapid-running waters. In all such experiments it is most essential that due regard should be paid to the ecology of the species subjected to artificial cultivation.

The report shows advance in our knowledge in several other respects also, as for example, the success obtained in keeping live oysters under artificial conditions at the Krusadi Biological Station, the construction of effective barriers against the enemies of pond-fishes, the success obtained in the use of $CO_2$ as the best preserving medium for the long storage of prawns, etc., etc. The achievements of the Department have encouraged the Imperial Council of Agricultural Research to subsidise a scheme of research for a central freshwater biological station and fish farm at Madras and another scheme of research relating to fish oil, guano and manure.

It is recorded with great satisfaction that a course of lessons in pisciculture is in preparation by the Department. It was a long-felt need and the fisheries are bound to benefit by such a regular course of training of the young men of the fishing community.

The report besides containing matters of general administration, is full of scientific results obtained by the Department during 1933–34. The Department, especially its energetic Director, is to be congratulated on the success achieved and it is hoped that under the patronage of the Imperial Council of Agricultural Research it will be possible to usher in a new era of fishery research in India.

S. L. H.

4 F

# Letters to the Editor.

## On the Dissociation of Some Molecules with Free Valencies.

IN continuation of an earlier paper[1] the correlation between the electronic terms of molecules of the type BeO, BeF and NO and those of the constituent atoms has been examined with the following conclusions :—

(i) Among the oxides and halides of the metals of the second group a good agreement between the energy of excitation of the products of dissociation and the terms of the metal atom obtains always, if the ground level of the molecule is correlated to the excited term sp $^3P$ of the metal. Besides the molecules BeF, MgF, CaF, SrF, already examined before, the following have been considered: BeO, MgO, CdF, BeCl, MgCl, CaCl.

(ii) In some of the molecules of these types also a correlation of the ground level to the repulsive term $s^2\ ^1S$ would appear to be possible, but others strictly contradict such a correlation. This is particularly evident in a case like CdF. Here the term difference $5s\,5p\ ^3P - 5\,s^2\ ^1S$ is enlarged, the metal belonging to the sub-group of the periodic table, while the energies of excitation and dissociation of the molecule are not very different from others of this type. Consequently one would have to assume that the linear extrapolation of the vibrational levels is incorrect by about 85 per cent. in order to obtain a correlation of the lowest state of the molecule to the $^1S$ term of Cd. The correlation to the excited term always agrees to about 1 to 2 per cent. with the experimental data.

This not only establishes the repulsive character of the $s^2$ group, but also, since no perturbation is observed in the bands, the absence of that type of hybridisation, which involves more than one term of the metal atom ($q$-linkage). This is also borne out by the crystal structure of the oxides which cannot be explained unless the single molecule exhibits still free valencies.[2]

(iii) In all the above molecules, terms whose energy of excitation is larger than that of the ground level are automatically correlated to an *anomalous* term of the metal atom.

(iv) In the molecules NO, PO and AsO the term with an increased energy of dissociation involves a configuration of the corresponding atom of the fifth group in which one electron is already excited to the next shell. A reasonable correlation can be obtained in SbO on the assumption that it behaves similarly. Of the different electronic terms whose relation is not yet known experimentally, the final state of the D system is to be regarded as the ground level of the molecule and the common final state of the B and C systems as the term with increased energy of dissociation. This shows again that the increase of stability on excitation in these molecules is always due to the excitation of that electron which does not take part in the linkage but represents a free valency.

A detailed report will be given elsewhere.

H. LESSHEIM.
R. SAMUEL.

Muslim University,
Aligarh,
*May* 15, 1935.

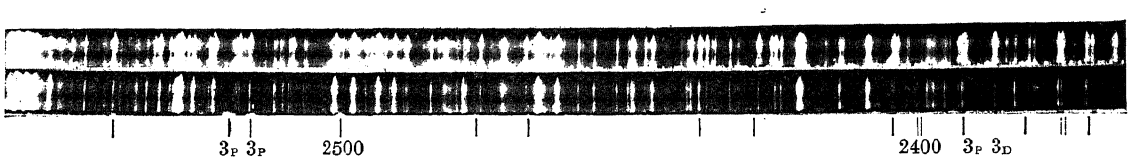
[1] H. Lessheim and R. Samuel, *Zs. f. Phys.*, 1933, **84**, 637; **88**, 276.

[2] F. Hund, *Zs. f. Phys.*, 1932, **74**, 1.

## Regularities in the Spectrum of Iodine IV.

FOLLOWING the analysis of Te III carried out in this laboratory, an investigation of the spectrum of Iodine IV of the same iso-electronic sequence was undertaken. The spectrum of a condensed discharge through Iodine vapour was photographed at various

H
L




H.—Higher Excitation. L.—Lower Excitation.

Quartz Spectrogram of Iodine Discharge.

stages of excitation, by using a Quartz Spectrograph of the Littrow type. The data thus obtained has led to the discovery of the important interval $6s\ ^3P_1 - {}^3P_2 =$

8252·3 cm.$^{-1}$, along with all the terms of the 6p-configuration. Adopting for the level $6s\,^3P_1$, a value 200532 cm.$^{-1}$ extrapolated from the corresponding values in Sn I, Sb II and Te III, a number of odd levels of the values of 202767, 201270, 200339, 199981, 198423, etc., have been obtained. Some of the important lines in the spectrum are marked in the print above. The detailed scheme will be published shortly.

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*June* 2, 1935.

## Diamagnetism of Elements in the Powdered State.

IT has been reported, that powders of bismuth,[1] antimony,[2] gold,[3] silver,[4] selenium,[5] etc., have considerably different susceptibility values than the metals *en masse*. In 1930 Bhatnagar[6] drew attention to the fact that the large changes reported in susceptibility could be due to a considerable extent to the presence of oxides and suboxides of the metals and to the adsorption of impurities by the fine powders. Mathur and Verma following this suggestion showed that after the removal of oxides both bismuth[7] and antimony[8] powders regain the original regulus value.

Rao[9] from his work on bismuth and antimony maintains that he obtains a critical value corresponding to the size of the macrocrystal after which a rapid change in the susceptibility ensues.

From Rao's papers one does not feel convinced that a high order of purity of materials has been attained in his experimental work. In the case of antimony, for example, no effort has been made to free it from the oxides. In the case of bismuth also, while an attempt has been made to free it from the oxides by treatment with tartaric acid as suggested by Bhatnagar, no critical experimental evidence has been given to show that the oxide is really completely removed. Nor has the probability of contamination with carbonates or bicarbonates been excluded, since it is well known[10] that these products are formed by keeping bismuth under water in the presence of air.

Selenium was examined by Dharmatti, who showed that on powdering, the diamagnetic susceptibility decreased and eventually changed in sign becoming paramagnetic. We have repeated Dharmatti's work and have some interesting observations to record. The red and grey allotropic varieties of selenium were subjected to prolonged powdering under benzene or toluene to prevent oxidation as far as possible. Only in an extreme case the value decreased from $-3 \cdot 03 \times 10^{-7}$ to $-2 \cdot 69 \times 10^{-7}$ at a particle size of $0 \cdot 4\,\mu$. In each case, however, the sample recovered the original value after washing with cold dilute hydrochloric acid. Also one of Dharmatti's paramagnetic samples made available to us through the courtesy of Prof. Mata Prasad regained the original value of Se on treatment with hydrochloric acid.

A very interesting observation made by us during the investigation was that the red variety gradually passed into the black one on protracted exposure to light. Transformation into the black variety has also been shown to take place under pressure by Von Schrott[11] and we suggest that the fall observed in certain cases may be due to the conversion on powdering into a metastable allotropic form having its susceptibility different from the original substance. This possibility seems particularly likely in the case of tin, which has been examined by Rao.[12] White tin *en masse* is weakly paramagnetic, but Rao finds that in the powdered form the susceptibility decreases with the particle size until for the smaller particles he finds that it becomes diamagnetic. As in previous cases, Rao has not taken care to discover the possibility of anything else responsible for the change. We are examining the case of tin and hope to communicate our results later.

In the end the authors wish to emphasise once again that in any work done with particles of colloidal sizes the exclusion of impurities which do accompany the powders on colloidisation is of permanent importance for it is only this, that can be responsible for erroneous conclusions. The authors also take this opportunity of thanking Prof. S. S. Bhatnagar for his help and guidance at every stage.

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*June* 4, 1935.

1 Vaidyanathan, *Indian Jour. Phys.*, 1930, **5**, 559.
2 Vaidyanathan, *loc. cit.*
3 Vaidyanathan and Singh, *Nature*, 1931, **128**, 302.

4 Vaidyanathan and Puri, *Nature*, 1932, **129**, 170.
5 Dharmatti, *Nature*, 1934, **134**, 497.
6 Bhatnagar, *Jour. Ind. Chem. Soc.*, 1930, **7**, 975.
7 Mathur and Verma, *Indian J. Phys.*, 1931, **6**, 181.
8 Verma and Mathur, *J. Ind. Chem. Soc.*, 1933, **10**, 321.
9 Rao, *Indian Jour. Phys.*, 1931, **6**, 241.
10 Mellor, *Comprehensive Treatise on Inorganic and Theoretical Chemistry*, London, **9**, 626.
11 Von Schrott, *Physical Zeit.*, 1907, **8**, 42.
12 Rao, *Proc. Ind. Acad. Sci.*, 1934, **1**, 123.

## The Diurnal Variation of Moisture in the Soil during the Clear Season.

EXPERIMENTS on soil moisture conducted by the Agricultural Meteorology Branch at Poona during the last two clear seasons (October-April) have shown[1] that during the clear season at Poona, when the surface layer of the soil is so far desiccated as to contain only hygroscopic moisture, the evaporation from the soil during the day is followed by absorption of moisture from the atmosphere during night by the soil. Under these conditions the soil does not undergo any material loss of moisture from day to day. The evaporation from and absorption by the soil result also in a variation of moisture in the air layers near the ground. These phenomena are therefore of particular interest to those engaged in a study of micro-climates and the meteorology of the air layers near the ground. This aspect of the subject has also been discussed in the above-mentioned paper.

In a later communication[2] we reported that samples of different soils kept in small vessels show characteristic intensities of "evaporation" and "absorption" when exposed to identical meteorological conditions. These observations have been confirmed by further experiments with a variety of soils during the last clear season.

The amplitude of the diurnal variation in the moisture contents of different soils expressed as a ratio of that of the Poona soil are given below :—

| Name of Soil | | Diurnal variation of moisture content expressed in terms of Poona Soil (=1). |
|---|---|---|
| Poona black cotton soil | .. | 1·00 |
| Dharwar black cotton soil | .. | 1·10 |
| Sholapur black soil | .. | 1·04 |
| Hagari | .. | 0·86 |
| Red Laterite | .. | 0·81 |
| Ranchi | .. | 0·65 |
| Jhelum | .. | 0·44 |
| Bangalore | .. | 0·29 |
| Pusa (alluvial) | .. | 0·20 |
| Lyallpur (alluvial) | .. | 0·21 |
| Sakrand (alluvial) | .. | 0·19 |
| Quartz powder | .. | 0·00 |

The above table shows that the black cotton soils undergo the maximum diurnal variation of moisture content owing to the loss of water by evaporation during day and gain by absorption from the air during night. The alluvial soils from the Indo-Gangetic as well as the Sindh areas experience only a fifth of the diurnal variation shown by the black cotton soils. Quartz powder appears at the bottom of the list with no variation. It is indeed remarkable that soils of the same type from places as far from each other as Pusa, Lyallpur and Sakrand have the same moisture variation index. A similar remark applies to the black cotton soils as well.

The epoch of *minimum soil moisture* content occurs a few hours after the epoch of maximum soil surface temperature (which occurs at noon), and coincides with the epoch of "maximum air temperature and minimum percentage humidity". The epoch of *maximum soil moisture* content coincides with the epoch of "minimum air temperature and maximum percentage humidity".

The hourly variation of the moisture content of the Poona soil at different depths has also been studied by taking actual hourly samples from the field and determining their moisture contents. It is seen that the diurnal variation is maximum at the surface and decreases very rapidly with depth, being practically insignificant even at a depth of 1″ below the surface.

The mechanical and chemical analysis of the soils used by us, the study of their adsorptive properties under laboratory conditions as well as experiments on their heats of adsorption and wetting are in progress. The results briefly outlined here are being discussed more fully in a forthcoming paper.

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M. S. KATTI.

Indian Meteorological Department,
Poona.
*June* 12, 1935.

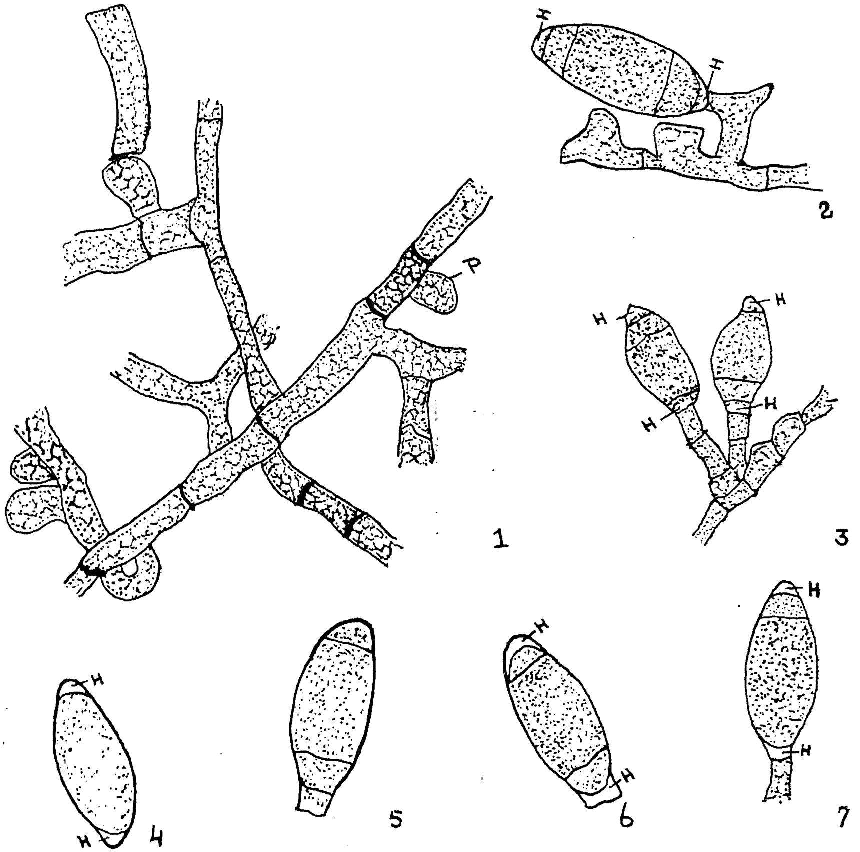
1 "Agricultural Meteorology: Preliminary studies on soil moisture in relation to moisture in the surface layers of the atmosphere during the clear season at Poona", by L. A. Ramdas and M. S. Katti, *The Indian*

*Journal of Agricultural Science*, Vol. 4, part 6, pp. 923–937.

2 "The Variation of Moisture in the surface layer of the soil in relation to the diurnal variation of Meteorological Factors," by L. A. Ramdas and M. S. Katti, *Current Science*, July 1934, Vol 3, No. 1, pp. 24–25.

## A Note on the Genus *Mitteriella*.

THE genus *Mitteriella* has been described by Sydow and Mitter[1] as a parasite on the leaves of *Zizyphus rotundifolia*. The specimen was collected from Majhgawan (a hilly tract between Manikpur and Satna, on the G. I. P. Railway). In 1930 when the material was first collected, very few bushes showed any sign of the parasite and only a single bush was badly infected. Here too, only the leaves were infected and branches or fruits were free from the fungus. Subsequent visits to Majhgawan year after year clearly revealed that the disease was becoming more and more common, because it was found that the leaves of a much larger number of *Z. rotundifolia* plants suffered from the same fungal infection. The luxuriant growth of the fungus observed in the first year was not found from 1932 to 1934 and no part of the plant except the leaves showed any sign of the parasite. During my last visit in January 1935 it




All the figures were drawn with the aid of a camera-lucida. Magnification—about × 650.

1—Branched hyphæ showing "Pseudopodia" (P).
2—A single attached spore.
3—2 attached spores arising near each other.
4, 5, 6, 7—Spores of various shapes showing different number of septa—Hyaline areas (H) are present in every spore.

was observed that the fungus was growing vigorously on many bushes and in addition to the leaves numerous branches and fruits were also infected by it.

From 1930 to 1934 a careful search was made for it in the neighbouring localities but was not found on this (*Z. rotundifolia*) or any other host. In 1935, however, during a

visit to Chitrakot it was found that numerous bushes of *Zizyphus œnoplia* were badly infected by *Mitteriella*. Every aerial part of the tree including the fruit showed serious infection.

This fungus has also been found on the fruit of *Zizyphus jujuba* collected from Majhgawan. The fungus growing on *Z. jujuba* and *Z. œnoplia* agrees with *Mitteriella zizyphina* in all details and therefore it is concluded that the three host species of *Zizyphus* mentioned above are infected by a single known species of the fungus, namely, *Mitteriella zizyphina*.

The following observations based on an examination of numerous collections seem to be worthy of record :—(1) The infection is greater during or after a severe spell of cold, and (2) The shady side of the bush is least and the sunny side most heavily infected.

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*March* 27, 1935.

[1] Sydow, H., and Mitter, J. H., "Fungi indici—1," *Annales Mycologici*, 1933, 31.

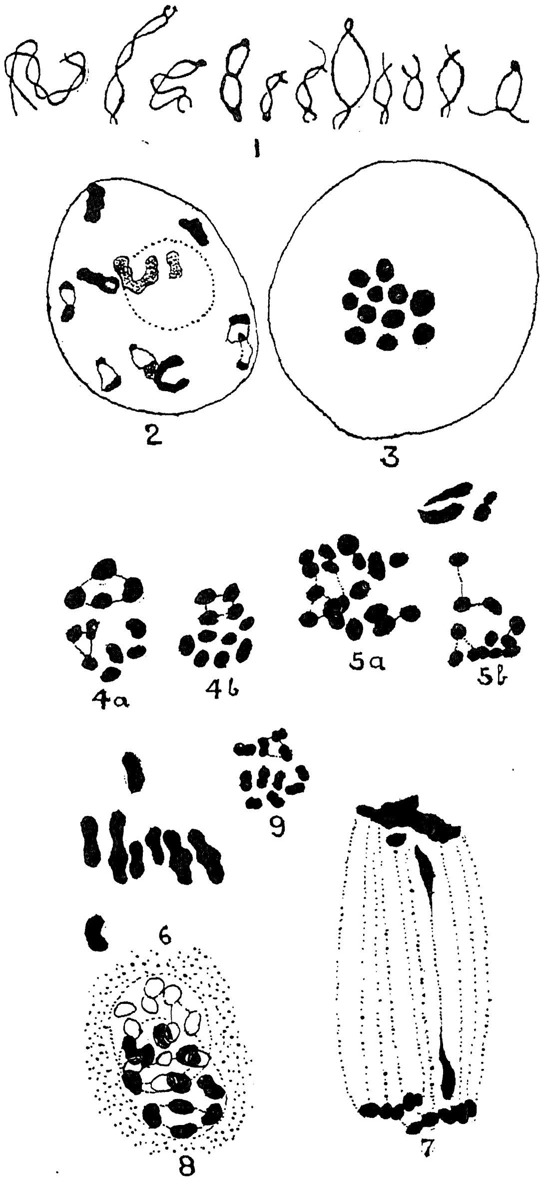
## Chromosome Numbers in *Cajanus indicus*, Spreng.

In the course of the examination of some pulses it was noticed that the chromosome numbers of some of them were not determined. One of them was the Dholl, *Cajanus indicus*, Spreng.— the pigeon pea, an important Indian pulse. The examination of this pulse was begun and the necessary material collected from the crop at the Millets Breeding Station in 1933.

Flower buds from the three following varieties were collected : (1) Short and early, (2) Medium height and duration, and (3) Tall and very late. (1) and (2) differ in degree ; (3) is a type with markedly big pods and seeds.

Flower buds were killed between 9 and 11 a.m. in Carnoy's fluid, which proved a good fixative on account of the hard calyx cup. Good fixations were also obtained in Allan's modification of Bouin's fluid when the buds were trimmed off at the top and bottom before being killed. The calyx on account of the hairs and oily exudations it contains, becomes hard and does not cut well. Its removal facilitates penetration. Sections were cut at 7–10$\mu$ and stained in Iron-alum Hæmatoxylin. Picric acid was used for destaining. All drawings were made with a Zeiss Camera Lucida, K. $\times 15$ ocular and 1·3 H. I. $\times 90$ objective. Figures were drawn to a magnification of approximately $\times$ 3000.

The first division stages are seen in buds 1–2 mm. long between 9·30–10 a.m. Later fixations give mostly second divisions. The




spireme is rather thin. At diplotene three chromosomes are seen to be longer than the others. The longer ones show more than 4

chiasmata, three out of the rest show 3 chiasmata and the remaining 5 show 2 chiasmata (Fig. 1). At diakinesis the latter show the chiasmata terminalised. Eleven pairs were counted at diakinesis (Fig. 2). The metaphase plate also gave 11 pairs (Fig. 3). In each variety 25 pollen mother-cells were counted and all of them gave the same number. This number eleven is the basic number of the *Phasioleæ* of which *Cajanus* is one.

The metaphase plate in all cases showed the chromosomes to be in association of 2, 3, 4 and rarely 5 (Figs. 4 *a* and *b*). No clear indications of such associations could be seen at diakinesis. Out of the 40 pollen mother-cells counted 25 were grouped up as follows:— 1+1+2+3+4. In other cases, associations in other groupings were also met with. The early anaphase gave also some indications of this association (Figs. 5 *a* and *b*).

Generally the anaphase is regular. In a few pollen mother-cells, however, one pair was found to be much earlier than the others and in other cases one pair was much later (Figs. 6 and 7). In the latter case the daughter chromosomes were seen slightly extended along the spindle. All the chromosomes reach the poles. The daughter nuclei gave eleven chromosomes (Fig. 8). One or more additional nucleoli were found in the resting daughter nucleus. No cell wall was formed.

Division II is generally more or less at right angles to the plane of Division I. The metaphase plates show the same associations here also (Fig. 9). The segregation is regular. A number of secondary nucleoli are seen. These are prominent in the early stages of the daughter nuclei formation but later become less evident.

The tapetum consists of one or two layers of large cells which often protrude into the anther cavity. These are seen persistent to a very late stage. The tetrads are formed by fission. The pollen is large, roughly triangular. The extine is thick and warty.

Since the above details were recorded, Basudev Roy[1] in the course of his "Studies in the Development of the Female Gametophyte in Some Leguminous Crop Plants of India," merely records 11 as the haploid number in *Cajanus indicus*. In view of the above detailed working of the cytology of this plant, this note is published.

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Coimbatore,
*April* 15, 1935.

[1] *Ind. Jour. Agri. Sci.*, 1933, 3, Part VI, p. 1098.

## Variation of Chromosome Numbers in Musaceæ.

WHITE[6] believed that the basic chromosome number in *Musa* was 4; Cheesman[1] showed that the basic number in the "banana series" is 11, and that all the edible bananas should be looked upon as triploids. He further suggested that this basic number is a secondary number probably derived from an original haploid number 8. This view is further strengthened by the fact that Tischler[5] found 8 "units" during the reduction division in the P.M.C. of a variety of banana described as "Dole" from Amani. The diploid number for this species, however, has been determined later on by Cheesman and Larter[2] to be $2n=22$. Similar observations have been made by us in a species provisionally identified as *Musa rubra* Wall., the details of which will be published later. In a recent publication, however, Cheesman and Larter[2] have found that the basic chromosome number in the three sub-genera of Musa (Physocaulis, Eu-musa, and Rhodochlamys), is different being 9, 11 and 10 respectively. From a comparative study of chromosomes in the different species of Musa and other genera they have arrived at the conclusion that the ancestral basic number of chromosomes in Musa is less than 11 and there exists a "heterogeneity rather than affinities, not only in the family Musaceæ but within the genus Musa itself".

Chromosome counts of the following species and varieties of Musa and Heliconia have been made in this laboratory and interesting results obtained showing a variation in the diploid number which are presented below.

It will be seen from the table that all the edible bananas studied have 33 as their diploid chromosome number. The only seeded variety studied, in the Eu-musa section, namely, *var. Aithya* has on the contrary $2n=22$ chromosomes. These observations corroborate the view of Cheesman and Larter[2] that the basic number in the Eu-musa section is 11. The present count of $2n=33$ in the variety *Amritasagar*, however, is not in agreement with White's[6] observations who finds $2n=36$ for the same variety.

TABLE I.

| Name of the Species and Varieties | Diploid Chromosome Number |
|---|---|
| Genus :—Musa | |
| Sub-Genus :—Eu-musa | |
| *Musa paradisiaca* L. | |
| Sub-species : *sapientum*. | |
| Vars. Champa kela | 32, 33, 34 & 35 |
| Safri | 32, 33 & 34 |
| Kancha kela | 33 |
| Aithya | 22 |
| Kabri | 33 |
| Dudsagar | 33 |
| Amritsagar | 33 |
| Agniswar | 32, 33 |
| Penang | 33 |
| *Musa Cavendishii* Lamb. | |
| Kabuli kela | 33 |
| —Rhodochlamys | |
| *Musa rubra* Wall. | 22 & 23 |
| —Physocaulis | |
| *Musa superba* Roxb. | 18 |
| Genus : —Heliconia. | |
| *Heliconia metallica* Planch. | 16, 18, 20 & 22 |

The other species provisionally identified as *Musa rubra* Wall. showed $2n=22$ chromosomes, though a clear plate showing 23 chromosomes has been observed. This observation appears to go against the view that the basic chromosome number in the section Rhodochlamys is 10.

In *Musa superba*, one of the two species representing the Physocaulis section of Musa in India, the diploid number was found to be $2n=18$, which is in agreement with the view of Cheesman and Larter,[2] that the basic number in this section is 9.

In *Heliconia metallica* Planch. a constant variation in the diploid chromosome number has been observed. Out of 25 clear plates, 3 showed 16, 4 showed 18, 10 showed 20 and 8 showed 22 as their diploid number. Cheesman and Larter on the other hand found the diploid number to be $2n=24$ in five out of six species investigated by them, and only in *Heliconia seemannii* they found the number to be $2n=22$. It is interesting to note, however, that according to Schumann[4] *Heliconia seemannii* Van Houtte ($2n=22$), one of the species investigated by Cheesman and Larter,[2] is synonymous with *Heliconia bihai* L. ($2n=24$). It appears, therefore, that variation in the diploid number of chromosomes in the same species is common in the genus Heliconia.

An aneuploid variation in the diploid number of chromosomes in the same plant has been previously recorded by d'Angremond[3] and Cheesman[1] in certain progenies of Musa hybrids. Cheesman and Larter[2] have found such a variation in the different roots of the same plant, the "Jamaica seedlings". According to them, these variations, though frequent, are due to chromosome fusion or loss during mitosis. From the above list, however, it will be seen that a constant variation in the diploid number of chromosomes, in the different cells of the same tissue, is a common phenomenon to be met with in certain varieties of Musa and Heliconia.

The presence of bi-nucleate and polynucleate cells and double number of chromosomes have been described by Cheesman and Larter[2] to be common in some varieties of Musa. Bi-nucleate cells have also been observed during the present study both in Musa and Heliconia, though double number

of chromosomes have not been observed up till now.

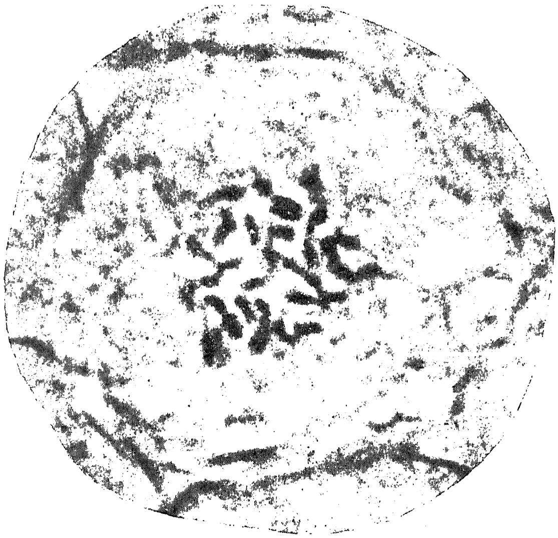

Fig. 1.
*Musa paradisiaca* L. Sub-Sp. *sapientum*. var. Champa Kela, stained with Haidenhain's Iron-alum Hæmatoxylin. ($2n=33$) ×2300.

Fig. 2.
*Heliconia metallica* Planch. Stained with Gentian Violet. ($2n=16$) ×2600.

It will be seen from the measurements given below as also from the figures above,

TABLE II.

| Name of the species and varieties | Length of Longest Chromosomes $\mu$ | Length of Shortest Chromosomes $\mu$ |
|---|---|---|
| *Musa paradisiaca* L. Sub. sp. *sapientum* | | |
| Var. *Safri* .. .. | 2·0 | 1·5 |
| *Aithya* .. .. | 2·5 | 1·5 |
| *Musa rubra* Wall. .. | 2·7 | 1·7 |
| *Musa superba* Roxb. .. | 2·7 | 1·7 |
| *Heliconia metallica* Planch. .. | 2·0 | 1·1 |

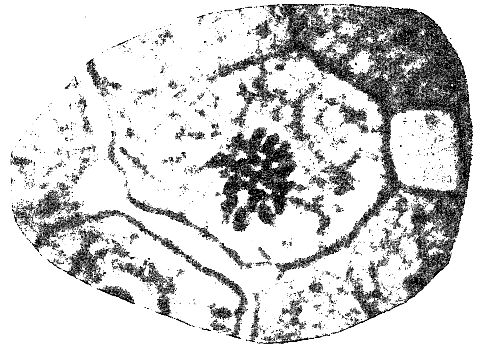

Fig. 3.
*Heliconia metallica* Planch. Stained with Haidenhain's Iron-alum Hæmatoxylin. ($2n=20$) ×1800.

that a variation in the sizes of chromosomes is marked in both Musa and Heliconia.

The marked tendency to grouping of chromosomes in chains, as has been observed during the present study, in some of the edible bananas and its absence in the seeded species, *Musa superba*, is another significant feature which has not been recorded by previous authors.

A more detailed investigation is in progress.

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*April* 26, 1935.

1 Cheesman, E. E., *Jour. Genet.*, 1932, **26**, 291–312.
2 Cheesman, E. E., and Larter, L. N. H., *Jour. Genet.*, 1935, **30**, 31–52.
3 d'Angremond, A., *Handel. Vierde Nederlandsch-Indisch Natuur. Congr., Velteverden.*, 1926, 360-367.
4 Schumann, K., *Das Pflanzenreich.*, Leipzig, 1900, 4, 45.
5 Tischler, G., *Arch. f. Zellforsch.*, 1910, **5**, 622–670.
6 White, P. R., *Zeitsch. f. Zellforsch.*, 1928, **7**, 673·

## Vivipary in Sorghum.

THE phenomenon of Vivipary, *i.e.*, the germination of the seed *in situ*, though rare, is not uncommon in the Angiosperms. It is not so common in the Gramineæ and is rare in cereals. Two cases are on record in cereals, both in Maize (Eyster, 1924).[1,2] Eyster calls these "primitive sporophytes". He notes that this character is heritable behaving as a simple recessive to the normal dormant condition. He finds that two independent factors, $pm_1$ and $pm_2$, are responsible for this vivipary.

In higher plants when the earhead is ripe the embryo stops its growth and lies in a dormant state. The endosperm remains practically unused. This cessation of growth

seems to be maintained very largely by an insufficient water supply.

In sorghum, an instance in which the embryo failed to go into the usual quiescent state has been met with. This occurred in *Sorghum papyrascens*, Stapf., M. S. 1401, a variety from the Central Provinces. *S. papyrascens* is like the other grain sorghums, *S. Durra*, Stapf. in practically every respect except that in it the glumes are long, thin, papery and transparent and do not have the usual keel clasping the grain. This kind of glume is more akin to the primitive condition represented by the absence of coriaceousness in the glumes of pedicelled spikelets. This *papyrascens* glume seems therefore to be a mutational manifestation of the normal glume. When this primitive type of glume occurs alone and without any other consequential changes, the usual sexual equipment ending in the normal big *Durra* grain, seems to receive an upsetting of the usual balance between the container and the contained. The *Durra* grain instead of being clipped up tightly below by thick, coiraceous glumes leaving a good bit of the grain exposed, now finds itself loosely and completely enclosed by the long, papery glumes. This mis-fit has its repercussions on the normal development of the lodicule and the consequent upsetting of its rôle as the regulator in the opening of flowers. The net result of this *papyrascens* mutant is a normal plant with an uneconomic earhead having a considerable amount of sterility in it.

The occurrence of this vivipary in one variety of this group of *S. papyrascens* is therefore understandable. A primitive type of glume has brought out this primitive endeavour at short circuiting the plant's life cycle. Family No. A. S. 149, in which a chlorophyll deficiency resulted in the production of pale green seedlings, belongs to the *papyrascens* group (G. N. Rangaswami Ayyangar and M. A. S. Ayyar, 1932).[3] Albinos have been noted by Eyster in his primitive sporophyte in maize. It will therefore be seen that papery glumes, vivipary, and chlorophyll deficiencies are of the bunch of residuary defects brought about by this mis-fit.

An examination of the seeds in the earhead manifesting vivipary showed that about 75 per cent. of the grains had germinated. Photographs of a viviparous grain (Fig. 1) and of twelve other grains in various stages of germination (Fig. 2) are given. It was suspected whether any particular position in the earhead stimulated this vivipary but an examination of the earhead, whorl by whorl, showed a fairly even distribution in its occurrence. Various endeavours were

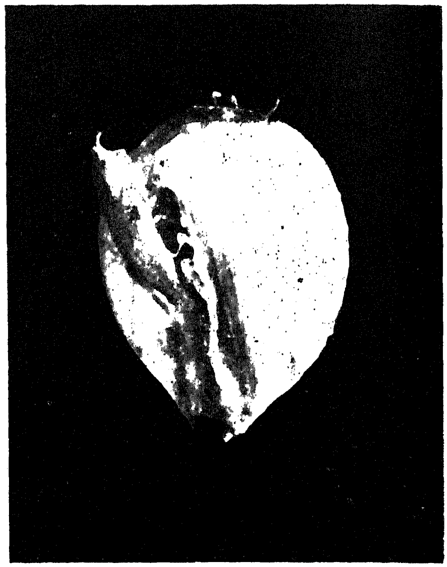

**Fig. 1.**
× 8.

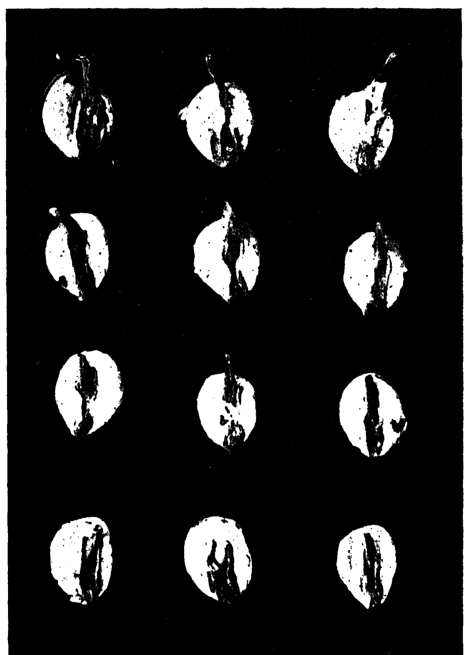

**Fig. 2.**
× 2.

made to germinate the seed but with only a single success. Even in this case the seedling died after a feeble endeavour at growth.

The genetic factors responsible for this occurrence of vivipary in Sorghum are under examination.

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Coimbatore,
*April* 22, 1935.

[1] *Amer. Jour. Bot.*, 1924, **11**, 7.
[2] *Amer. Nat.*, 1924, **58**, 436.
[3] *Ind. J. Agri. Sci.*, 1932, **2**, 266.

## On the Nature of the Papaghni-Cheyair Sequence.

IN describing the "Kadapah and Karnul formations in the Madras Presidency", King[1] believes in the existence of an unconformity between the Papaghni and the Cheyair divisions of the lower Cuddapahs. Recently however Dr. A. L. Coulson who examined these formations in connection with the occurrence of Barytes and Asbestus in this area, contends that this unconformity does not exist or "if it exists at all, is so small as to be negligible".[2] In all the places where King has noticed an unconformable junction, Coulson believes that the quartzites overlying the Papaghnis are *not* the Pulivendla quartzites of the Cheyairs but belong to the Banganapallis, the basal member of the very much younger Kurnool formation. While this explanation may be true in some cases, we cannot believe that it is of universal application throughout the Papaghni-Cheyair area. We have recently had opportunities of examining many localities where we see the Papaghni-Cheyair junction and have made several observations which go to support King's conclusion regarding the existence of an unconformity.

(1) In several places as for instance at Vaimpally (14° 25′ 30″ : 78° 14′), Chandana (15° 5′ : 77° 49′) and Balapalapalle (15° 27′ 30″ : 78° 6′ 30″), we see the Vaimpally shales and limestones (Papaghni) overlaid by the quartzites which are admittedly (even by Coulson) of the Pulivendla (Cheyair) subdivision. In all these places, the quartzite begins with a coarse conglomeratic facies containing, among others, pebbles of oolitic chalcedony or chert. According to King "these contained fragments of oolitoid siliceous chert are common to the lowest breccias and conglomerates of nearly the whole extent of the western outcrop of the Pulivendla quartzites". These pebbles could have been derived only from the chalcedonic bands with oolitic structure, which we know are exclusively confined to the Vaimpally limestones—thus showing distinctly that the latter must have started being denuded prior to the deposition of the conglomeratic quartzites. (2) Moreover the quartzites immediately above the conglomeratic zone in all the three localities show such evidences of shallow-water deposition as current-bedding, ripple-marks, etc., and could not have been deposited at depths of more than 8-10 feet—thus indicating the proximity of the shore line. (3) If according to Coulson the Papaghni-Cheyair sequence were unbroken, one would have expected to see a gradual grading of sediments from the Vaimpally shales or limestones to the pure quartzites above. We are not aware of any such occurrence—the transition from the lower to the upper series being always abrupt and well defined. (4) Another evidence pointing to the existence of a Papaghni-Cheyair unconformity is seen near Donakonda (2 miles east of Nayanapalli). Here we see the shales and limestones of the Vaimpally sub-division have a strike 20° west of north and dip 10° east, while the overlying Pulivendla quartzites strike 45° west of north and dip 20° east—distinctly suggesting an angular unconformity.[3] (5) From our study of the trap rocks seen between the Papaghnis and the Cheyairs near Talapalli (5 miles west of Vaimpally) we have reasons[4] to believe that this trap flow is "subaerial" and not "sub-marine". The subaerial character of this lava flow which overlies the Vaimpallys and underlies the Pulivendlas must naturally lead one to infer an unconformity between the two divisions.

From what has been said above, it appears to us that the unconformity between the Papaghnis and the Cheyairs is not so 'negligible' as Coulson suggests.

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*May* 29, 1935.

[1] *Mem. G.S.I.*, **8**, pt. 1.
[2] *Mem. G.S.I.*, **64**, pt. 1, pp. 3 & 6.
[3] *Geologic Structures*, B. & R. Willis, p. 44.
[4] These will be discussed in a separate paper on the trap rocks of the lower Cuddapahs to be published shortly.

# The Arc Spectrum of Iron in the Photographic Infra-Red Region.

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THE production of the new photographic Infra-Red plates on a commercial scale has made accessible spectral regions up to about γ 13,000, that can now be investigated with spectroscopic accuracy. This unexplored region involves the necessity of having suitable standard lines that could be employed in other direct and indirect calculations.

The use of the Iron Arc and the various conditions under which it has to be employed are too well known to be mentioned here; and the adoption of this Arc for the Photographic Infra-Red region seems probably inevitable. A number of investigations have been made from time to time with the Iron Arc and some measurements on the Solar lines are also available. Although the early investigations were hampered due to the difficulties in the technique of photographing this region, some progress has been made; I give below a short summary of the previous work carried in this direction:

Burns[1,2,4] published his measurements on the Arc Spectrum of Iron using the grating and gave wavelengths up to λ 8825. Along with it the Interferometric measurements are also available for the Arc up to the same region[3].

A list of Red and Infra-Red lines of Iron was published by Meggers and Kiess[4a] giving data up to λ 10,375.

Randall and Barker[4b] gave observations of the Iron Arc extending to λ 26,727 with Infra-Red Spectroscopic arrangements.

Meggers and Kiess[5] measured lines of Iron Arc till λ 8825.

A list of Solar lines was published by Babcock[6] and also by Meggers and Brackett containing measurements with the Interferometer up to λ 9000. Unfortunately the solar radiation cannot be employed in the laboratory as a convenient source due to many difficulties.

Babcock[7] gave his Interferometric measurements of Neon and Iron lines up to λ 7585.

In the meeting of the International Astronomical Union held at Leyden in 1928, Iron and Solar radiations[7a] were adopted for further use till λ 8825 and these have been slightly altered recently.[12]

Measurements of Iron lines are available after Burns and Walters[8] till λ 9653.

Querbach[9] measured the arc spectrum of Iron up to λ 8866.

The lines were measured by McLennan and Quinlan[10] till λ 9000.

Meggers and Kiess[11] gave measurements of Iron lines till λ 10,863.

Schmitz[13] measured the Iron lines till ~λ 9000.

Recently Dingle[14] has published the wavelengths of Iron lines up to λ 10,218 "which cannot be used as final standard".

Using specially sensitized plates Meggers[15] has investigated the Arc Spectrum of Iron till ~λ 12,000 and this is probably the first thorough investigation so far available.

From time to time attempts have been made to compile a list of wavelengths available for the Iron Arc lines in this region.

Catalan[16] published a number of Iron lines in tabular form and Kayser and Konen[16a] have compiled a list of the lines.

Schmitz[13] gave a comparison table of some of the wavelengths in his dissertation.

The new volume of the *Handbuch der Spectroscopie*[17] contains a detailed account and discussion of the Iron lines in the Visible and Ultra-Violet

*Arc Spectrum of Iron—Some Intense Lines.*
*(Meggers.[15])*

| Int. | λ(air) | Int. | λ(air) |
|---|---|---|---|
| 250 .. | 7164,469 | 1500 .. | 8220,406 |
| 800 .. | 7187,341 | 1200 .. | 8327,063 |
| 500 .. | 7207,406 | 1200 .. | 8387,781 |
| 400 .. | 7495,088 | 300 .. | 8468,413 |
| 800 .. | 7511,045 | 600 .. | 8661,908 |
| 300 .. | 7780,586 | 1500 .. | 8688,633 |
| 400 .. | 7832,224 | 250 .. | 8824,227 |
| 700 .. | 7937,166 | 200 .. | 8999,561 |
| 600 .. | 7945,878 | 100 .. | 9738,624 |
| 700 .. | 7998,972 | 30 .. | 10065,080 |
| 600 .. | 8046,073 | 40 .. | 10145,601 |
| 500 .. | 8085,200 | 50 .. | 10216,351 |

[1] K. Burns, *Liek. Obs. Bull.*, 1913, **247**, 8, 27.

[2] K. Burns, *Z. f. wiss. Phot.*, 1913, **12**, 207.

[3] K. Burns, *C.R.*, 1913, **156**, 1611; *J. de Physique*, 1913, (5) **3**, 457.

[4] K. Burns, *Fortsetzung Z. f. wiss. Phot.*, 1914, **13**, 235.

[4a] W. F. Meggers and C. C. Kiess, *Sci. Pap. Bur. St. Nr.*, 1918, 324.

[4b] H. M. Randall and E. F. Barker, *Ast. J.*, 1919, **49**, 42.

[5] W. F. Meggers and C. C. Kiess, *Sci. Pap. Bur. of St. Nr.*, 1924, **479**.

[6] H. D. Babcock, *Ast. J.*, 1927, **65**.

[7] H. D. Babcock, *Ast. J.*, 1927, **66**, 256.

[7a] *Trans. International Astronomical Union*, 1928.

[8] K. Burns, *Pubs. Alleg. Obs.*, 1930, **6**, 159.

[9] J. Querbach, *Z. f. Phys.*, 1930, **60**, 109.

[10] J. C. McLennan and F. M. Quinlan, *Trans. R. Soc. Canada*, 1930, **24**, part I, 47.

[11] W. F. Meggers and C. C. Kiess, *J. Research*, 1932, **19**, 309.

[12] *Trans. International Astronomical Union*, 1933.

[13] L. Schmitz, *Diss.*, Bonn., 1934.

[14] H. Dingle, *M. N. R. A. S.*, 1934, **94**, 866.

[15] W. F. Meggers, 1935 (In Press); *J. Research*, 1935, **14**, 33.

[16] Catalan, *Annales de la Soc. Esp. de Fis. y. Quin.*, 1930, **28**, 1239.

[16a] H. Kayser and H. Konen, *Handbuch der Spectroscopie*, 1932, Bd. **7**, 1239.

[17] H. Kayser and H. Konen, *Handbuch der Spectroscopie*, Bd. **9** (in Press).

regions. A list of lines is also given for the near Infra-Red region.

Plates of the Iron Arc Spectrum till $\lambda$ 8824 are available after Meggers and Kiess[5] and Dingle has given a photograph till $\lambda$ 10,218.

The members of the International Astronomical Committee are considering the question of the Iron Standard lines in this region and very soon standard wavelengths will be available.

My thanks are due to Prof. H. Kayser and Prof. H. Konen for making their excellent libraries accessible to me and encouragement.

# Research Notes.

## Moments of Hypergeometric Series.

A. A. KRISHNASWAMI AYYANGAR obtains a general expression involving determinants for the moments of the Hypergeometric series about its mean (*J. Ind. Math. Soc.*, 1934, **1**, 4). The author considers his formula to be more useful than the one given by Romanovsky (*Biometrika*, Vol. XVI) for the first six moments. The author also gives a recurrence formula for evaluating his determinants for higher moments.

In the same number of the Journal Brij Mohan Mehrotra has a short note on "Some Self-Reciprocal Functions," in which he formulates some corollaries of theorems published by him previously.

Ram Behari discusses an integral invariant connected with rectilinear congruences. Considering the ruled surface $\xi = x + uX$, $\eta = y + uY$, $\zeta = z + uZ$ where $(x, y, z)$ denotes a point on a closed curve, the invariant considered is $p = \int_c (Xdx + Ydy + Zdz)$. Several interesting properties of $p$ and $\frac{dp}{dS}$ are discussed.

## Artificial Radioactivity produced by Neutron Bombardment.

IN the *Proceedings of the Royal Society*, 1935, **149**, 522, Fermi and his collaborators have given a description of a further instalment of their interesting experiments on artificial Radioactivity. Having noticed that the activity produced by neutron bombardment is profoundly influenced by hydrogenated substances, they have systematically studied the effect of water on the activity of all the newly-produced radio-elements. There are some cases in which the activity is largely influenced as, for instance, Na, Al (2·3 m.), V, Ag, Cu, Rh and I; in others the influence of water is very small as in the case of Si, Al (10 m.), Mg, Mn and Zn. In every case in which the active element is known to be an isotope of the bombarded one (about 20 instances), they find that the activation is increased by the presence of water. This result is explained by assuming that the slowing down of the neutrons by the protons contained in the hydrogenated substances makes it easier for these neutrons to be captured by the struck nucleus. In order to verify this hypothesis experiments were made to determine the absorbing power of various materials for slow neutrons and they found that the absorption was abnormally high in some instances as B, Y and Cd. Except in these cases of abnormal absorption it was found that each absorbed neutron produced one activated nucleus; the abnormal absorption is probably connected with the formation of stable isotopes. The mean energies of the activating neutrons have also been measured and all the results are given in a table at the end of the paper. The effect of non-hydrogenated substances is also to increase the activation by slowing down the neutrons but the effect is not so intense as in the case of hydrogenated substances. Another important result due to the new investigation is the conclusion that when a new radio-element isotopic with the struck nucleus is produced, the new nucleus is of higher atomic weight and results from the capture of the neutron. The separation of the radio-active isotope from the bulk of the bombarded element was also found possible since the activated molecules are left in an atomic or ionic condition. The method was employed in the case of bromoform, chloroform, carbon tetrachloride and sodium chlorate, to separate radio-active bromine and iodine. Radio-active arsenic was obtained from cacodylic acid and radio-active manganese from potassium permanganate. A systematic investigation of all the elements revealed a number of new facts both as regards the induced activities and the properties with respect to slow neutrons; all these are consolidated in a useful table at the end of the paper. The authors have also carried out new chemical tests on the products obtained by bombarding uranium and find further support for their previous claim about the production of transuranic elements. They

conclude that the 15 sec., 13 min., and 100 min. activities are due respectively to products with atomic numbers 92, 93 and 94 and atomic weight 239.

T. S. S.

## Masses of Some Light Atoms.

An accurate determination of the masses of some of the fundamental particles such as the proton and the neutron is a most important necessary preliminary work in a programme seeking to elucidate the nature of these particles. The values obtainable by considering the results provided by the mass-spectrograph and those deduced from considerations of the masses and energies of the particles taking part in a nuclear encounter seemed to be in conflict. But recently Aston has been constructing a new mass-spectrograph designed to study the masses of (light) atoms by comparing the positions of close doublets such as O and $CH_4$, $C^{++}$ and $D_3$ etc. and has reported the result of some preliminary measurements in *Nature*, 1935, **135**, 541. The values he obtains are much higher than those previously given by him and the difference he attributes to imperfect resolution in his older instrument. The new values are in agreement with those deduced by Oliphant, Kempton and Rutherford (*Proc. Roy. Soc.*) from a consideration of a number of nuclear reactions, particularly those arising when beryllium and boron are bombarded by deutons. According to the new estimates, the mass of the neutron is slightly larger than that of the proton, but not so high as 1·0092 as estimated by Curie and Joliot. Possibly Wentzel's conclusion that the mass of the neutron is equal to that of the hydrogen atom is near the truth. The following table gives a comparison of the values found by Aston and those estimated by Oliphant, Kempton and Rutherford:—

| | Aston | Oliphant *et al* |
|---|---|---|
| ${}_0n^1$ | .. | 1·0083±0·0003 |
| ${}_1H^1$ | 1·0081 | 1·0081±0·0001 |
| ${}_2He^4$ | 4·0041 | 4·0034±0·0004 |
| ${}_6C^{12}$ | 12·0018 | 12·0027±0·0003 |

T. S. S.

## Absolute Rates of Migration of Ions.

The moving boundary method for the determination of the transference numbers of ions is reliable only if the potential gradient under which the ions move is accurately measured. Mukherjee and his co-workers (*J. Indian Chem. Soc.*, 1935, **12**, 177) have developed a method for the accurate determination of the migration velocity of ions, involving a technique similar to the measurement of the cataphoretic speeds of colloidal particles as described by Mukherjee (*Proc. Roy. Soc.*, 1923, A **103**, 102). Considering the boundary between hydrochloric acid solution and picric acid, it has been shown that with the movement of the ions under a potential gradient, the migration of the picrate ion increases with time while that of the chloride ion decreases. Though the boundary remains sharp during the interval of the observations, it has been shown that a slight mixing up of the solutions may account for large variations of the mobilities. Hence the initial migration velocity of the ions before mixing takes place with simultaneous measurement of the potential gradient across the boundary gives reliable values.

M. P. V.

## Krypton Content of Atmospheric Air.

The literature on the quantitative estimation of Krypton and Xenon in the atmosphere is very scanty. Sir William Ramsay, the pioneer research worker in rare gases of the atmosphere, published an estimate of the Krypton concentration (*Proc. Roy. Soc.*, 1900, **67**, 329) and gave a value of $1 \times 10^{-6}$ which was later on corrected to $5 \times 10^{-8}$ and still another correction was made in a subsequent paper. His method was fractional distillation. Moureu and Lepape adopted the method of fractional adsorption on cocoanut charcoal and estimated by spectro-photometric examination of Krypton line in a "Plucker" discharge tube and gave the value of $1 \cdot 31 \times 10^{-4}$ Krypton : argon (parts by volume).

Dr. Brody and Dr. Körösy (*Trans. Faraday Soc.*, 1935, **31**, 547) adopted a purely chemical procedure for the separation of the rare gases of the atmosphere, avoiding all doubts arising from fractional distillation or adsorption, obtained spectrograms of emission in an electric discharge and determined the relative intensity of the spectrum lines of Krypton in relation to some of the weaker argon lines. A series of argon-Krypton mixtures of known composition were prepared, the relative intensities of the same lines determined and the Krypton content of "air argon" calculated by interpolation. They arrive at the value of $1 \cdot 6 \times 10^{-4}$ Krypton:

argon. The argon content of air being 0·935 per cent. by volume, the Krypton content is $1 \cdot 5 \times 10^{-6}$ volume parts (*i.e.*, $1 \cdot 5 \times 10^{-4}$ per cent. by volume) the most accurate value up to the present as claimed by the authors.

K. S. R.

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### Chemical Composition of Root-Rot Affected Peas.

CHARACTERISTIC differences in the chemical composition of peas affected with root-rot as compared with peas from healthy plants are noted and discussed by Kertesz, Horsfall and Rouse in the *Journal of Agricultural Research*, Vol. 49, No. 9. The root-rot under reference is not due to any single organism but a complex comprising *Pythium* Spp. and *Rhizactonia solani* Kuhn. The striking difference in outward appearance, is the decidedly larger size of the affected peas in really all stages of ripeness, due, it is suggested, to the quicker translocation of Carbohydrates into the ovules. The injured root system seems to curtail the water, nitrogen and ash supply, which results in the setting of peas with a lower water-content and a lower ash and nitrogen contents in the dry matter.

A. K. Y.

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### Plant Growth as Influenced by the Deficiency of Available Soil Manganese.

CHLOROSIS associated with insufficient available manganese in the soil has been studied by B. E. Gilbert and the results of several years' experiments connect definitely Mn chlorosis with soil alkalinity (*Rhode Island Sta. Bul.*, 246). In the soils studied the critical range seemed to lie between PH 6·8 and 7·6, though it could not be linked with soil type. Crops differed greatly in their susceptibility. In certain cases Mn deficiency resulted in decreased yield without visible chlorotic symptoms.

Spraying the plants with sulphate of manganese at the rate of 8 lbs. per acre afforded a ready means of correcting the defect, as likewise in the alternative by manuring with the sulphate at the rate of 30 lbs. per acre ; the effects of the manure did not persist, however, for more than a year as a corrective. Manuring with sulphate of ammonia or other means of counteracting the effect of excessive liming also acted as a preventive (abstracted from the *Expt. Stn. Record*, January 1935).

A. K. Y.

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### The Sugar Content and Odour of Clarified Extracts of Plants as related to Their Susceptibility to Insect Attacks.

INVESTIGATIONS tending to show that the susceptibility to attacks by the Japanese beetle (*Papillia Japonica* Newm.) is more in plants, the clarified extracts from which are low in their content of reducing sugars and which possess a fruity odour than in those whose extracts show a higher sugar content and possess no such fruity odour, are described by Metzger, Van der Meulen, and Mell in the *Journal of Agricultural Research*, Vol. 49, No. 11. The plant extracts were mostly from leaves, and with ethyl alcohol, the clarification being effected by lead acetate: the investigations related to 97 species and varieties of plants. The extent to which plant extracts of various kinds can act as an attractant or as a repellent affords a study of much economic value in combating insect pests either by the method of baiting and destroying or by that of keeping them off, and it will be a fruitful line of work if a study with this subject should be systematically undertaken in regard to crop pests of this country.

A. K. Y.

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### Kiln Drying of Wood with Ozonized Air.

THE use of ozonized air for kiln-drying of wood has been advocated, particularly in France, as it is claimed to give better results than the usual methods. The addition of a small quantity of ozone to the air has been supposed to accelerate and facilitate seasoning, especially in the case of refractory timbers. It has also been claimed that ozone-dried timber suffers less from seasoning defects and is less susceptible to atmospheric influences. In his little book of twenty pages, Mr. Kapur (*Indian Forest Records*, Economy Series, Vol. XX, Part XIII) describes the experiments carried out by him at the Forest Research Institute, Dehra Dun, on the kiln-drying of various species of Indian timber with ozonized air. Experiments with and without ozone carried out under otherwise identical conditions showed conclusively, that from the practical point of view, kiln-drying with ozonized air has

absolutely no advantages over the usual methods. In fact, the idea that ozonized air has any beneficial effect in seasoning wood is proved to be more or less a superstition.

C. V.

## The Dutch Elm Disease.

A. W. McCALLUM, Forest Pathologist, has described (Pamphlet No. 159, New Series, Department of Agriculture, Canada) a fungus disease affecting the elms in the United States since 1930. Elms are commercially important in Canada and generally rank fourth among the hard-woods in regard to annual production. It is also one of the most valuable ornamental trees valued for its rapid growth, attractive form and moderate shade.

Sudden wilting and yellowing of leaves is one of the most characteristic external symptoms. The leaves get shrivelled, and become brittle and the disease, particularly in the case of big trees, may be confined to one or two branches at the commencement. Diseased trees often produce vectors along the main stem and the bases of large branches.

Internal symptoms consist of a broken or complete ring of brown dots in the cross-section of the sap wood. A longitudinal section will reveal brownish streaks varying in number according to the roots as well.

The fungus (*Graphium Ulmi*) is principally spread from tree to tree by means of spores adhering to the bodies of elm bark beetles and is also wind-borne. Control measures consist of decapitation of affected limbs in the case of partially affected plants but if the main stem is affected, nothing can be done to save the tree. To prevent the fungus from spreading to healthy trees, it is necessary to destroy those already infected. It is hoped the enforcement of such extreme control measures, if taken early enough, may result in the total elimination of the fungus.

M. S.

## Rôle of *Tabanus Orientis* Wlk. and *Stomoxys Calcitrans* Linn. in the Mechanical Transmission of Rinderpest.

RINDERPEST being the most common and fatal of epizootics in India any addition to the existing knowledge of this dire disease is most welcome. Bhatta has reported the results of his experiments to find out if *Tabanus Orientis* Wlk. and *Stomoxys Calcitrans* Linn. are incriminated in the transmission of this disease (*Indian Journal of Veterinary Science and Animal Husbandry*, 1935, **5**, Part I). The experiments which were very carefully conducted have proved that *T. Orientis* can transmit the disease under natural conditions from the infected to healthy cattle although *S. Calcitrans* was found to be incapable of doing so. It had been known that *Glossina morsitans* was a confirmed vector of the disease in Africa. The present experiments have conclusively shown that *Tabanus* is involved beyond doubt in the transmission of the disease in India. The writer suggests further experiments with other species of biting and non-biting flies in order to conclude which of them are probable vectors so that necessary control measures may accordingly be adopted to check the spread of Rinderpest among bovines in this country.

S. D. A.

## The Diet and the Brain in Fishes.

B. S. BHIMACHAR (*P. R. S.*, Series B, 1935, **177**) has pointed out some interesting correlations between the feeding habits and the structure of the medulla oblongata in the South Indian Cyprinoid fishes. These fishes, according to their feeding habits, can be divided into two main groups 1. those which feed by taste, and 2. fish which feed by sight. In the former group the fishes are bottom feeders and the taste buds in pharynx (Lepidocephalicthys) or on the barbels and the snout (Nemachilus) are responsible for sorting out food and correspondingly their nerve centres in the brain, either the vagal or the facial lobes, are very well developed in these forms. In the sight feeders (Rasbora, Nauria, Danio and Chela), the vagal and the facial lobes are very small and there is a well developed central acoustic area or lobe.

## The Brain of Gadus.

AN important contribution to our knowledge of the piscine brain has been made by H. Muir Evans (*P. R. S.*, 1935, **177**), in his paper on the brain of Gadus. In the first part of the paper he describes in detail the medulla oblongata of the Whiting (*Gadus merlangus*) and compares it, with serial

sections of the corresponding regions, with that of the Roach. An attempt has been made in the second part to correlate the structure of the hind brain with the feeding habits of different Gadidæ.

The author lays considerable stress on the existence of true facial lobes in Gadidæ since their presence in these forms has been denied by previous workers. It has been stated that, while identifying the various lobes of the brain, important consideration has to be given to their histological structure in addition to the nerve trunks and their associated tracts. The somatic sensory area or the 5th lobe is very prominently developed in the predacious members of the Gadidæ, while the facial lobes are well developed in the forms which feed on crustaceans, molluscs and worms. The dentition is also modified according to the nature of the diet.

## Basic Xenoliths and their Grain-size.

DURING recent years a large volume of literature has developed dealing with the various aspects of the basic xenoliths, but few people have attached any importance to the apparent relationship between the grain-size of the xenolith and that of the host rock. This problem has been lately studied by Miss Joplin of Cambridge (*Geological Magazine*, No. 851, May 1935). She has made a detailed study of the xenoliths and their grain-size, and depending upon the work of such well-known petrographers as Nockolds, Tilley and Campbell Smith, she has come to the conclusion that in most cases xenoliths are more fine-grained than the host rock. This discrepancy is brought about by recrystallisation and hybridisation in rocks. Under the influence of thermal metamorphism, large mineral individuals are broken up into smaller granular units, thus bringing about a reduction in grain-size. Similar effects are produced in metamorphic rocks where poikilitic structure is so common. Discussing the case of hornblende in this connection, she has suggested that when criss cross flakes of biotite are developed it leads to a finer texture. Further it is interesting to note that at a late stage in the hybridisation of rocks, hornblende becomes so highly poikilitic that disruption is imminent, and a slight movement of the magma is sufficient to produce a fine-grained aggregate.

# Science Notes.

*Paraffin Films in the Study of Infra-red Absorption Spectra.*—Drs. N. R. Tawde, Y. G. Naik and D. D. Desai, of the Royal Institute of Bombay observe: "Great difficulty generally presents itself in the preparation of paraffin windows for absorption chambers in the infra-red work. Essential factors in preparing a proper film are (i) the homogeneity of the film, and (ii) the thickness of the film.

"While studying the experimental technique of infra-red absorption measurements, we tried various methods of preparing such films. The process of preparing a film on the water surface was rather easy, but it had the following defects: (*a*) The film was not of uniform thickness, (*b*) it cannot be made very thin, for in doing so, it gets perforated, and (*c*) it is not homogeneous throughout, for there is every chance of water vapour remaining embedded within the film, thereby increasing the absorption of the infra-red radiation. After enclosing the HCl gas for about 24 hours in a chamber closed with this film, minute acid drops were formed on both sides of this film, showing that it was permeable to HCl gas for the thickness desired. It was therefore best if the films were quite free from any traces of moisture.

"M. Czerny (*Zeit. f. Physik*, 1927, **44**, 235) and L. Kellner (*Zeit. f. Physik*, 1929, **56**, 215) have described a method of preparing this film by pouring paraffin on a plate of glass which was previously heated, and on which, a thin membrane of celluloid was spread. The film was taken out by removing and breaking off the celluloid membrane. The thickness of the film thus obtained was rather high, *i.e.*, 1.2 to 1.5 mms. or even more.

"During our experiments, we thought of preparing the film by spreading paraffin on a clean surface of mercury which was kept at a suitable temperature. The advantages of using this method are found to be the following: (*a*) no trace of water will interfere; (*b*) the film is of uniform thickness throughout; (*c*) the film of any desired thickness can be formed; and (*d*) the film is not permeable to HCl gas or air. There is not the slightest trace of moisture on the outside surface.

"In order to test the homogeneity and uniformity of the thickness of such films, we have examined the absorption for heat rays, of the films prepared both on water and mercury surfaces. These were obtained with thickness within the desired range and examined for absorption at various sections of their area under identical conditions. The mean value of percentage absorption was determined in each case. The deviation of various readings from the mean showed that for the thickness desired for the purpose of these experiments, the paraffin films prepared on mercury surface give, on the whole, better results than those prepared on water surface. This can be verified from the following which is typical of the different sets of readings taken."

| Film prepared on surface of | Thickness of the film | Mean % absorption | Deviation from the mean | |
|---|---|---|---|---|
| | | | Max. % | Min. % |
| | mm. | | | |
| Mercury .. | 0.375 | 73.402 | 0.1771 | 0.1635 |
| Water .. | 0.55 | 76.88 | 0.43 | 0.26 |

* * *

*Notes on "A study in the mode of pollination, in* Portulaca quadrifida *Linn."*—Mr. S. Ghose, St. Xavier's College, Calcutta, writes :—"While making a study of the physiological causes of the movement of the petals and leaves of *Portulaca quadrifida* L., I observed that the pollination of the flowers of the plants under observation showed a very interesting change in their mode of pollination. The pollination of the flowers of *Portulaca grandifolia* Lindl. and *P. oleracea* Linn., was studied by De Bonis (*Riv. fis. mat. Sc. nat.*, Pavia, 1893) and Kerner (*Nat. Hist. Pl. Eng. ed.* 1,11,395) respectively and they found the flowers of these plants to be either partially or wholly *cleistogamous*.

"The flowers of *Portulaca quadrifida* L., however, show a very interesting change in their mode of pollination. The terminal portion of the axis on which the flowers grow is cup-shaped, inside which the flowers remain concealed, surrounded by four terminal opposite leaves. In continuous deep shade or in darkness the flowers do not open, but remain enclosed in the fold of the leaves, thus ensuring *cleistogamy*.

"But in course of this study, I found the following facts which distinctly indicate *chasmogamy* or cross-pollination. (1) Flowers always terminate a vertical branch. (2) Flowers though very small are made conspicuous by their large numbers, bright yellow colour of the petals, and all blooming at a time. (3) As the day advances the flowers emerge out of the cup-shaped axis and the folds of the leaves and place themselves quite exposed. (4) An average of about two hundred readings shows that light and water supply being sufficient the flowers all open between 10-45 A.M. and 11 A.M. and remain open for about 2 hours and 25 minutes. (5) The style is longer than the filaments of the stamens. (6) Serial sections of some freshly opened flowers showed no sign of pollination. (7) Ants, flies and sparrows are found to visit the plants when the flowers remain open.

"Study of the above facts show that the pollination in *Portulaca quadrifida* L., is dependent on external conditions, such as light, temperature and humidity.

"A complete paper will be communicated elsewhere."

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*A Note on Microspore-formation in* Melosira varians *Ag.*—Mr. M. Abdul Majeed, Botany Department, Government College, Lahore, writes :—"Microspore-formation has been studied in *Melosira varians* Ag. at its natural habitats in Lahore and its vicinity and experiments have also been performed to produce it culturally in the Laboratory.

"Although the Knop's solution did not give much satisfactory results with this Diatom, the writer, however, was successful in cultivating it on the solid media of Agar Agar. (Method employed by Richter-Rein Kulturen von Diatomeen, 1906).

"The long filaments within a period of 8-10 days broke up into single individual frustules, and the inner contents of the protoplast by numerous successive divisions formed 8-16 or more protoplasmic bodies (microspores), each 4-6$\mu$ in diameter. These naked cells later on emerged out of the frustules after about a fortnight or so and then developed new siliceous walls."

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*Birthday Honours :—*

*Knighthood.*—Dr. L. L. Fermor, O.B.E., D.Sc., F.G.S., F.R.S., Director, Geological Survey of India. *C.I.E.*—Lt.-Col. R. Knowles, I.M.S., Professor of Protozoology and Secretary of the Calcutta School of Tropical Medicine. *Dewan Bahadur.*—Rao Bahadur L. K. Ananthakrishna Ayyar, B.A., L.T. *Rao Bahadur.*—Mr. M. Vaidyanathan, M.A., L.T., F.S.S., Statistician, Imperial Council of Agricultural Research. *Rao Sahib.*—Dr. T. V. Ramakrishna Ayyar, Entomologist, Agricultural Research Station, Coimbatore.

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*Wind Data for Wind Mills.* By V. Doraiswamy Iyer, B.A., *Scientific Notes*, India Meteorological Department, **6**, No. 63. Pp. 57-85.—Monthly normals of wind velocity for 205 observatories in India and a few stations in the neighbouring countries are given and the distribution of wind velocities in the different seasons is illustrated by charts. Curves of the diurnal variation of wind velocity at 22 stations for the four seasons are given. Tables giving the frequencies of occurrence of winds of different speed ranges, and of days with different total duration of windspeeds exceeding 6 miles per hour which is considered the minimum for working a wind mill for agricultural purposes, have also been prepared for fifteen stations. The data presented are briefly discussed.

* * *

*Chromium Steels.*—[His Majesty's Stationery Office, Price, (Post Free) 8s.]. This book presents a comprehensive review of published information on the plain chromium steels, and gives a detailed account of their history, constitution, mechanical and physical properties. The uses of plain chromium steels (structural steels, case hardening steels, steel castings, gauges and dies, ball bearings, rails, valves, etc.) are also dealt with and some hitherto unpublished work carried out at the Research Department, Woolwich, is described. The treatment of the subject will make the work of interest and value to metallurgists and engineers.

* * *

*The Cadak Festival.*—In a paper presented before the Asiatic Society of Bengal, at an ordinary meeting held on the 3rd June, Mr. K. P. Chattopadhyaya described a festival observed in Bengal, called the Cadak festival, which is associated with the vernal equinox. The ceremony begins a week before the end of the month of Caitra (March–April) and culminates on the last day of that month, which also marks the close of the year in Bengal. This date is known

as the day of the passing of the sun into Aries (Mahāviṣuva saṁkrānti). Actually it comes after the day of the vernal equinox by about three weeks. The name, however, indicates clearly the association with the equinoctial day which once did coincide with this date. The end of the year in Bengal appears in course of time to have lagged behind to this extent. The traditional origin of the festival is that on this date king Vāṇa in order to please Mahādeva, drew blood from his body as an offering and propitiated him by dances (along with friends) which are favoured by him.

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*Gold Deposits in Trichy.*—It is understood that Mr. Naraindas Girdharidas has taken prospecting mines' lease for exploiting auriferous quartz, carrying pyrites and gold, with horn blende and mica schist. The mines have been tapped in a village in Kulitalai Taluk, Trichy District. The veins running across cover an area of 3 square miles.

* * *

*Glass Manufacture in Hyderabad.*—The Department of Commerce and Industries has recently given a fillip to the work of reviving old industries by starting a glass factory in the suburbs of the Hyderabad City. The factory has been equipped with up-to-date plant and is located close to a range of hills rich in quartz.

The manufacture of paints and varnishes has also been started, and it is hoped that very soon the State will be able to supply her local needs. It may be mentioned that, at present, the total imports exceed ten lakhs of rupees.

* * *

*Fruit Cultivation in Hyderabad.*—The Imperial Council of Agricultural Research has recently given a grant to the Agricultural Department for carrying on research work on grapes and custard apple. The activities of the Agricultural Department in the development of fruit cultivation have recently been intensified with the result that keen interest has been aroused in the farmers. An extensive survey of the fruit growing industry has already been made and in the Aurangabad District, which is reputed to be the best fruit growing area in the State, experimental gardens have been established at Himayatnagar, Sangareddi, Parbhani, Warangal and Raichur. Training classes have been started in the experimental farms where students receive instruction in the scientific methods of fruit culture.

* * *

In the course of an address on the future of sugar industry in India delivered before the Royal Society of Arts, London, Mr. B. C. Burt, Agricultural Adviser, Imperial Council of Agricultural Research, said that the season 1935–36 will see about 145 modern factories in operation with an estimated combined capacity of 810,000 tons of sugar annually. For further expansion in Northern India there is little room. The development in the south will be gradual. There is great scope for factory sugar, and this can be seen from the fact that for the quinquennium ending 1931, the average consumption was 961,000 tons. The sugarcane crop which is an all-times crop has given the Indian cultivator a relatively large income for his labour and employment throughout the year; by closer co-operation between the factories and growers, the future of the Indian Sugar Industry will be assured.

* * *

*Preparation of Sugar Syrup from Cashew Apple.*—The Department of Industries, Madras Government, have during recent years taken keen interest in the development of cottage industries. Recently they organised a demonstration at Mangalore on the preparation of sugar syrup from cashew apple, a fruit which is now being exploited mainly for the cashew nuts. The juice that can be extracted from the pulp contains about 10 per cent. invert sugar. But the tannins, phenols and other unknown constituents of the fruit juice render it unsuitable for use. Besides, the juice perishes very quickly. To preserve and make available the sugar of this apple, it is necessary, therefore, to remove the undesirable constituents and prepare a concentrated syrup. This is done by treating the juice with slaked lime, filtering off the precipitate formed through cloth, adding a little acid and concentrating the filtrate in an open pan over a fire, to about a sixth of the original volume of the juice. Thus a thick syrup is obtained, golden yellow in colour and almost odourless. About an ounce of syrup could be prepared from five fruits at little cost.

The syrup, containing as it does only invert sugar, is easily assimilable and therefore makes an important article of food. Its greater use, however, would be in preserves and confectionery.

* * *

At the time of the tenth anniversary celebration of the Establishment of the Indian Cotton Committee and the Technological Laboratory, on 29th May, certain extensions to the field of activities envisaged by the laboratory were made.

The laboratory was originally intended for helping cotton breeders to evolve new varieties of cotton which would be an improvement over existing varieties, in point of yield, hardihood, ginning percentage, spinning quality, etc. The work of the laboratory was next extended so as to undertake the tests on samples submitted either by the East India Cotton Association or the Mill Owners Association of Bombay and Ahmedabad. A certain amount of work was also done to determine the susceptibility of cotton to certain insect pests. Researches on the properties of cotton fibre, as well as on the effect of the different processes on the quality of yarn spun from a cotton was also being carried out.

It is now proposed to extend the scope of the laboratory, so as to afford facilities for investigations on bleaching, dyeing, mercerising, and finishing operations. The laboratory will also embark on a scheme of propaganda for disseminating scientific and technical information available to the indigenous industry.

In this connection, it may be pertinent to refer to the recent statement of Mr. H. C. Shrot, who recently visited India, before the Lancashire Indian Cotton Committee, in which he mentioned that while in India he was shown several strains of cotton which compared very favourably with some of the cotton now being imported by Great Britain from foreign countries. It would take some time before these cottons could be produced in India in large quantities, but in a few years India would be able to supply England cottons, fully equal to what they were purchasing elsewhere at present.

*Pulp and Paper Conference.*—A conference of pulp and paper interests in India met at Calcutta on March 13th and 14th, and as a result of the discussions it was proposed to request the paper pulp section of the Forest Research Institute at Dehra Dun to investigate, (1) The mechanical treatment of bamboo prior to digestion, (2) Manufacture of mechanical pulp from bamboos, (3) Treatment of mixed species of bamboos, (4) Examination of Sabai grass (*Ischoemum angustifolium*) from different areas with regard to percentage yield of pulp and bleach consumption, and (5) Investigation of the various causes responsible for the discolouration of pulps and papers made in the mills.

According to an Editorial note published in the *Indian Forester*, the work will be taken in hand by the Forest Research Institute and carried out as quickly as staff and funds permit.

* * *

Under the auspices of the Indian Society, London, an exhibition was organised at the Alpine Club Hall; the collections of Mr. J. P. Baker, one of the world's foremost textile printers, consisting of beautiful specimens of hand painted cotton of the eighteenth century are on view. These exhibits, which have been grouped under three classes, pure Indian, Chinese influence, and Western influence, cannot fail to impress the glorious art that was India's.

* * *

A scientific expedition under the leadership of Professor Mark of Vienna University, has discovered that glacier ice on the Jungfrau (Switzerland) contains heavy water in 1 : 2,500 concentration which is double that present in normal ice. (*Chem. Age*, 1935, **32**, 405.)

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What is considered to be the world's rarest liquid, "heavy oxygen water" is now being produced at the University of Manchester by means of a recently constructed diffusion apparatus. Professor M. Polanyi and J. B. M. Herbert recently demonstrated the production of heavy oxygen water by the newly designed apparatus which is capable of yielding only 2/5 of a drop per day. One atom out of every 100 of oxygen has an atomic weight of 18, and the concentration of heavy oxygen is considered to be an achievement, since the difficulties are much greater than in separating the three kinds of hydrogen recently discovered.

* * *

Professor William C. Rose of the University of Illinois recently announced the results of his experiments on the isolation of $\alpha$-amino-$\beta$-hydroxy butyric acid, an amino acid which is claimed to be absolutely essential to growth and life. This essential amino acid has also been prepared synthetically. About five years ago, Dr. Rose and his associates fed animals with a mixture of foods free from protein but containing a mixture of all the 21 amino acids then known. The animals receiving such a food declined rapidly in weight and eventually died. This was interpreted to indicate the presence, in proteins, of a hitherto unknown component which was essential to life. Further research resulted in the isolation of the new amino acid, which when added to a protein-free diet containing the 21 previously known amino acids produced normal growth.

An Electrolytic Process for extracting case and lactose from skimmed milk, described J. Kato (*J. Soc. Chem. Ind. Japan*, 1934, No. utilises a three-compartment dialyser. The t end compartments are filled with water a contain respectively a carbon anode and a bra cathode. Adjoining the anode is a chromat gelatine-impregnated silk membrane while t membrane at the cathode is made of similar impregnated canvas. These membranes oppo passage of lactose towards the central chamb Strict control is kept of the acidity in the cent compartment. During electrolysis (100 vol 1 amp.), a gradual reduction in hydrogen-i concentration is recorded as the various metal ions (calcium, magnesium, potassium, et migrate to the cathode compartment while t acidic ions pass into the anode compartmen On approaching the iso-electric point, case begins to coagulate and is separated in a ve pure form by filtration while the filtrate is lactose solution likewise free from all but trac of mineral salts. Chemically pure lactose isolated by evaporating in a vacuum, and cent fuging. (*Chem. Age*, 1935, **32**, 405.)

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According to a note appearing in *Scien* (1935, **81**, Science News, page 8) Dr. F. A. Gibb H. Davis and E. L. Gareeau of the Harwa Medical School, reported to the American Physi logical Society that an electrical hook up to th brain producing wavy lines traced on pape gives a new clue to what goes wrong in epileps They find by this means that epilepsy is probab a neurological storm which results in gre piling up of electrical discharges.

* * *

According to a note appearing in *Scien* (1935, **81**, 340) the cause of the synchrono flashing of fireflies is really to be sought in t mating habits of these insects. Professor Jol Bonner Buck of the Zoological Laboratory, T Johns Hopkins University, has shown that *Photinus pyralis*, the male flies emit single flash about every 5.7 seconds. The female remai in the grass, and responds to some near ma by flashing shortly (2.1 seconds) after each his flashes. This exchange of signals continu until the male reaches the female. The essenti factor involved is that the female who flash only in response to the flash of the male invariab maintains the period of about 2.1 seconds which she replies to the flash of the male. striking feature of this "attraction" is th whereas the exchange of signals is initiated by single pair, other males within a range of abo 10 feet often join in also, so that as many as flies may fly towards one female. The sar response may be induced by selecting a male an in proper imitation of the female, flashing a torc light about 2.1 seconds after each of his flashe

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*Marketing Officers for Travancore.*—At the joi meeting of the Assembly and the Council Travancore presided over by Sir Muhamma Habibulla, a sum of Rs. 3,440 was set apart f the appointment of marketing officers.

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Professor S. C. Dhar, D.Sc., of the Nagpu University has just returned after a brief sojou from Europe. During his stay in Europe, l spent some time with Professor Whittaker, ar

made some valuable contributions on Relativity and Autographic Functions. He also spent some time with Professor Hadamand of Paris and his dissertation on Mathiew Functions is regarded as a standard work on the subject.

* * *

The Council of the Royal Society, London, has awarded Dr. M. N. Saha, a sum of £150 for research on the theory of the Thermal Ionisation of Gases. Dr. Saha has also been awarded the Carnegie Research Scholarship for the year 1935-36 by the American Carnegie Authorities for the above purpose. Dr. Saha is leaving for America in September next. He will undertake a world tour before returning to India.

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Dr. J. J. Rudra, at present Lecturer in Electrical Technology, Indian Institute of Science, Bangalore, has been appointed to the Chair of Electrical Engineering, College of Engineering, Madras. He is leaving Bangalore very shortly to take up his new post.

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Mr. D. Ananda Rao, Principal, Agricultural College, Coimbatore, has been appointed Director of Agriculture in succession to Mr. S. V. Ramamurthi, I.C.S.

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Mr. V. Ramakrishna, I.C.S., Director of Industries, Madras, has been appointed Deputy Secretary to the Government of Madras, Labour and Industries Department. Mr. L. B. Green has been appointed Director of Industries, Madras in succession to Mr. V. Ramakrishna, I.C.S.

* * *

*The Mathematics Student* (Vol. II, No. 4, December 1934):—(1) Pandit Hemraj gives alternative proofs of a certain extension of Wilson's Theorem in the theory of prime numbers, originally stated and proved by Gauss. (2) T. R. Raghava Sastri proves the following theorem: If ABCD and A′B′C′D′ are two homographic tetrads of points on a conic S, the six meets of pairs of corresponding joins like AB, A′B′ together with the six meets of pairs of non-corresponding joins like AB, C′D′ lie on a conic passing through the pole with respect to S of the homographic axis of the two tetrads. Several corollaries and special cases are discussed. (3) A. Narasinga Rao discusses and interprets in terms of mechanics the proper and improper solutions of the following problem: Given any number of points, $A_1, A_2, \ldots A_n$, not necessarily coplanar and a function $f(r)$ which is single-valued, continuous, positive and monotonic increasing to infinity with $r$, it is required to determine the position of a point P such that

$$\phi(P) = a_1 f(r_1) + a_2 f(r_2) + \ldots\ldots + a_n f(r_n)$$

shall be a minimum, the $a$'s being positive constants, and $r_1, r_2, \ldots\ldots$ the distances $PA_1$, $PA_2, \ldots\ldots$ (4) K. Rangaswami discusses some properties of ortho-lines and "orthopoints" with reference to conics passing through A, B, C and P, and conics having ABC as a self-polar triangle.

* * *

We have recently received from Messrs. Activated Sludge Limited, London, a pamphlet on the activated sludge plants in India by Dr. Gilbert J. Fowler, D.Sc., F.I.C., F.R.San.I. The pamphlet gives brief summaries of the studies made and the results obtained from the eleven installations, which have been kept under scientific supervision, at any rate, during the earlier periods of their operation; and consequently they are all virtually scientific experimental solutions by means of which the very varying conditions such as are met with in India, have received careful study. Nine of the eleven plants are in actual operation to-day: two others which have been in satisfactory operation, were closed down at the end of their experimental periods.

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*Deming Pumps.*—We have recently received a catalogue (No. 30) of the Deming Pumps, of Messrs. The Deming Company, Salem, Ohio, U.S.A., which, we believe, will prove to be of great interest to all those interested in pumping equipments—distributor and dealer, architect and engineer, and industrial executive. The Firm which enjoys a world-wide reputation, was established fifty-four years ago, and has specialised in pumps construction, a feature which is responsible for the progressive spirit and traditional quality associated with the Deming name. The catalogue draws attention to a very wide range of equipment—centrifugal and rotary pumps and cylinders, spray pumps, etc.—which will meet every requirement.

* * *

*Announcement:—*

*Congress of the F.E.A.T.M.*—Dr. Rosedale writes:—At the next Congress of the Far Eastern Association of Tropical Medicine it is proposed to hold a round-table discussion on nutrition.

Papers are invited upon Nutrition from the widest point of view under any of the sub-headings below.

If suitable support is forthcoming, it may be possible to combine the papers received and the discussions in a volume, which would constitute an up-to-date account of Nutrition as concerns the East.

It is hoped that some indication of the support which may be expected may be received during 1935, though it will not be necessary for titles of papers to be sent in until a later date which will be notified in due course. Such co-operation will enable the Council to know how much time should be allotted for the discussion.

It has been proposed to divide papers under three headings as follows: *I. Economics*—to include such aspects as Agriculture in relation to human nutrition, *e.g.*, improvement of yield and quality of food crops; horticulture; fruit-growing; stock raising; dairy problems; institutional feeding; food surveys; storage; cooking, &c. &c. *II. Chemical and Physiological*—to include food analyses in the widest sense; vitamin, mineral, fat, protein studies, etc.; metabolism, basal metabolism, energy requirements, specific dynamic action. *III. Clinical*—Studies of diseases in relation to food and diet, the feeding of infants during the first year with special reference to development (height and weight); children's diseases in relation to food; nutritional œdema, atrypical beriberi; the course of infectious diseases under the influence of food; liver cirrhosis; anæmias; skin diseases in relation to food and vitamins; ulcers of the leg; leprosy in relation to food; constitutional diseases, diabetes, obesity, gall-stones, gastric ulcer, etc.; clinical value of certain foods, etc.

It should be understood that the above provisional programme is intended to be as wide as

possible, and that additional suggestions from those able to make them will be welcomed. It is hoped that the subject of nutrition will receive emphasis from the general and normal point of view as well as from the point of view of disease.

All correspondence should be addressed to The Director of Public Health, Parapattan, 10, Batavia—C, Tara, Netherlands, Indies.

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We acknowledge with thanks the receipt of the following :—

"Journal of Agricultural Research," Vol. 49, No. 12 ; Vol. 50, Nos. 1–3.

"The Journal of the Royal Society of Arts," Vol. 83, Nos. 4301–4304.

"Indian Journal of Agricultural Science," Vol. 5, Part I, February 1935.

"Contributions from Boyce Thomson Institute," Vol. 7, No. 1, Jan.–March 1935.

"The Biochemical Journal," Vol. 29, No. 4, April 1935.

"American Journal of Botany," Vol. 22, No. 4, April 1935.

"Canadian Journal of Research," Vol. 12, No. 4.

"The Chemical Age," Vol. 32, Nos. 826–829.

"Berichte der Deutsche Chemischen Gesellschaft," Vol. 68, No. 5.

"Experimental Station Record," Vol. 72, Nos. 3 and 4.

"Electrotechnics," No. 8, April 1935.

"Forschungen und Fortschritté," Vol. 11, Nos. 13 and 14.

"Indian Forest Records," Vol. 20, Part 16, (Silviculture Series).

"Transactions of the Mining and Geological Institute of India," Vol. 30, Part I, May 1935.

"Indian Meteorological Department: Scientific Notes," Vol. VI, No. 63. Wind Data for Wind Mills.

"Bulletin of the U. P. Academy of Sciences", Vol. III, 1933–34, No. 5 ; Vol. IV, Part II.

"Proceedings of the Academy of Sciences (United Provinces of Agra and Oudh, India)," Session 1934–35, Vol. IV, Part III.

"Industrial Possibilities of some Research Work done in India," by Dr. G. J. Fowler.

"Advance Proceedings and Notices of the Asiatic Society of Bengal," Vol. II, April–May 1935, No. 2.

"Nature," Vol. 137, Nos. 3417–3419.

"Natural History," May 1935.

A Report on the Prospects of Paper Manufacture in Hyderabad State, H. E. H. The Nizam's Government: Commerce and Industries Department. Bulletin No. 4 (New Series).

"Survey of India, Geodetic Report," 1934.

"The Journal of Chemical Physics," Vol. 3, No. 5.

"Journal de Chemie Physique," Vol. 32, No. 4.

"The Indian Trade Journal," Vol. 118, Nos. 1509–1511.

*Catalogues.*

"Deming Pumps," Cat. No. 30, from the Deming Co., Salem, Ohio.

"The Cambridge Bulletin," No. 76, May 1935.

"Mitteilungen über Neuerschienungen und Fortsetzungen," 1935. No. 3 (May). Verlag. von Gustav Fischer in Jena.

## Academies.

### Academy of Sciences (United Provinces of Agra and Oudh, India):

*February 1935.* S. M. SHAH : *On a Formula for* $\pi r$ *(x)*. SHAH MUHAMMAD SULAIMAN : *The Mathematical Theory of a New Relativity. Chapters III, IV and V.*—The first two chapters dealt with the Law of Gravitation. In chapter III the existing theories of the Universe have been very briefly criticised, and it is shown that extraordinary assumptions are made in these and that they are also wholly inadequate. In chapter IV a natural assumption has been made that emanations from particles of matter are not confined to our present range of observation, but that corpuscles called gravitons, finer than light corpuscles, are also emitted, though they are beyond our vision. But even this assumption is not necessary. As shown in Section V, one may start simply with the known fact that light radiations, *i.e.*, swarms of light corpuscles or radions, emanate from every part of an outer shell of a luminous body. In chapter V the assumption in Special Relativity that light from one moving body to another moving body takes the same time as light from the second body to the first, no matter how different their velocities may be, as well as the definition of common time between two bodies determined by a single journey of light are not accepted. With the help of certain generalised laws, Galileo's and Newton's Mechanics, with proper corrections for moving bodies, is completely restored: and although Einstein's Theory of Relativity is not accepted, all its practical results are deduced in full. HRISHIKESHA TRIVEDI: *The Absorption Spectra of the Vapours of Sulphur Monochloride and Thionyl chloride and their Constitutions.* HAR DAYAL SRIVASTAVA : *Studies on the Family* Heterophyidæ Odhner, 1914. *Part I—On a New Distome from the Indian Fishing Eagle*–Haliæetus leucoryphus—*with Remarks on the Genera* Ascocotyle *Looss*, 1899, *and* Phagicola *Faust*, 1920.—The paper is the first record of the occurrence of a member of the family Heterophyidæ. S. K. DUTTA: *Notes on a Case of Unilateral Atrophy of Testis in the Common Wall Gecko* (Hemidactylus Flaviviridis, *Ruppel*). HAR DAYAL SRIVASTAVA : *On a New Species of* Catatropis Odhner, 1905, *from an Indian Fowl*—Gallus Bankiva Murghi.—A large number of monostomes referable to *Catatropis Odhner* were obtained from the rectal cæca of the domestic fowl, which had died after a prolonged sickness. CROMWELL OSBORN DAS & SIKHIBHUSHAN DUTT : *A Study of Some Organic Reactions at Low Temperatures.* RADHA RAMAN AGARWAL AND SIKHIBHUSHAN DUTT: *Chemical Examination of the Roots of* Citrullus colocynthis *Schrader*—A hydrocarbon hentriacontane $C_{31}H_{64}$, $a$-elaterin $C_{28}H_{38}O_7$ and amorphous saponin have been isolated.

### Indian Academy of Sciences :

*May 1935.* SECTION A.— B. V. RAGHAVENDRA RAO: *The Doppler Effect in Light Scattered by Liquids.*—The influence of temperature on the nature of Doppler Effect in light scattered by carbon tetrachloride has been studied. Whereas

at 70° C. the Doppler components become fainter and broader merging with the undisplaced component which brightens in intensity, at the temperature of melting ice, the Doppler components become sharper and move away from the central component. N. A. SHASTRI: *Some Properties of the* k-*Function with Non-integral Index.* S. CHOWLA: *On a certain Arithmetical Function.* P. N. KURIEN, C. J. PETER AND K. C. PANDYA: *The Condensation of Aldehydes with Malonic Acid in the Presence of Organic Bases. Part III—The Condensation of Salicylaldehyde with Ethyl Malonate*—Good yield (58%) of the condensation product was obtained when 0.15 mol. of pyridine was added to the mixture of aldehyde and ester, the whole kept on a waterbath for 18 hours (6 hours a day for 3 days) and then left at room temperature for 3 days. INDER CHOWLA: *Some Problems of Waring's Type.* R. S. KRISHNAN: *The Reciprocity Theorem in Colloid Optics.*—The conclusions derived from the dynamical Principle of Reciprocity admit of a very simple and direct experimental test which has been carried out and found to be satisfied by all kinds of colloidal solutions, emulsions, suspensions, etc., irrespective of size, shape or structure of the particles contained in them. HANSRAJ GUPTA: *Decompositions into Squares of Primes.* T. S. WHEELER: *On the Theory of Liquids, III.*—An attempt has been made to consider the vibratory motion of the molecules, and the amplitude of vibration $\beta$ has been linked with the density, internal latent heat of vapourisation, surface tension, viscosity and vapour pressure. Formulæ relating viscosity with surface tension, and vapour pressure with internal latent heat have also been obtained. P. K. RAMAN: *Heat Radiation from the Clear Atmosphere at Night.* K. R. RAMANATHAN AND L. A. RAMDAS: *Derivation of Ångstrom's formula for Atmospheric Radiation.*—The processes taking place in the neighbourhood of the ground on radiation nights are complicated, and for their elucidation, the changes taking place both in the soil and at higher levels in the atmosphere have to be studied. R. K. ASUNDI: *The Band Systems and Structure of CaCl.* N. S. NAGENDRANATH: *The Dynamical Theory of the Diamond Lattice, Part II.—The Elastic Constants of Diamond.*—The expressions for the elastic constants of diamond have been found in terms of the molecular force constants and their values have been evaluated approximately. C. S. VENKATESWARAN: *The Raman Spectra of Some Metallic Halides.*—The paper describes the results of the study of the Raman Spectra of the halides of cadmium and zinc as well as of magnesium chloride, magnesium bromide and aluminium chloride.

SECTION B.—BIPIN BIHARI SINHA: *Morphology of a New Genus of Trematode, Family* Aspidogastridæ *Poche,* 1907, *from the Intestine of a Tortoise,* Lissemys punctata. R. H. RAMACHANDRA RAU: *Mechanism of Increase in Amylase Activity during Autolysis of Barley Powder.*—During the autolysis of barley powder no amilokinase is formed, observed increase in amylase activity being solely due to increased liberation of $\beta$-amylase of barley. S. S. PATWARDHAN: *On the Structure and Mechanism of the Gastric Mill in Decapoda. V. The Structure of the Gastric Mill in Natantous Macrura Caridea.*—The paper deals with the tribe Caridea of the Natantous Macrura, characterised by the absence of a gastric mill. Eighteen types of Caridea have been examined. FROILANO DE MELLO: *On a Toxoplasmid of* Fulica Atra *L. with Special Reference to a Probable Sexuality of Agametes.* B. SAHNI AND A. R. RAO: *Further Observations on* Rajmahalia paradoxa.—The revised impression regarding the peculiar plant impression from an unknown locality at the Rajmahal Hills, regards it as an inverted funnel-like organ fallen from the top of a Bennettitalean receptacle and bearing on its inner surface the impress of the seeds and interseminal scales once pressed against it, but now no longer preserved. R. GOPALA AIYAR: *Early Development and Metamorphosis of the Tropical Echinoid* Salmacis bicolor, *Agassiz.*—The full development of *Salmacis bicolor*, a tropical form has been traced both in regard to the external characters and several internal features. PRAKASH CHANDRA JOSHI: *Development of Anomalous Secondary Vascular Rings in the Root of* Spergula *L.*—The anomalous secondary growth in the Vascular cylinder of the root of the two species of *Spergula*, *S. rubra* and *S. pentandra*, is recorded, and the details of such development in *S. rubra* have been described. B. N. SINGH AND K. KUMAR: *Photosynthetic Behaviour of Leaves to Variations in Temperature.*—The progress of assimilation from day to day in a young radish leaf for 20 days is deduced from the separate time-assimilation curves of mature and old leaves and the effect of variation of temperature is recorded. B. N. SINGH AND K. KUMAR: *The Reactions of the Assimilatory System to Alterations of Light Intensity.*—At the normal atmospheric pressure of carbon dioxide the intensity of assimilation increases measurably with the intensity of illumination upto 68,760 metre candles in radish leaves. P. J. GREGORY: *Cytological Studies in Safflower* (Carthamus Tinctorious *Linn.*).—The cytology of this plant of economic importance has been investigated and reported for the first time. J. F. DASTUR: *Diseases of Pan* (Piper Betle) *in the Central Provinces.*—A detailed account of foot-rot, leaf-rot and anthracnose diseases which are known to occur in epidemic form is given.

# Industrial Outlook.

## Future of Electrical Development in India.

By T. D. Chatterji,

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### General Outline.

THE unprecedented grid-developments from water power during the last five years in the Punjab, United Provinces and Madras Presidency has well established the adaptable possibilities in fields of Industry and rural electrification, that can be attained from the energy of the vast water resources of India. At the same time the recent decision of the Government of United Provinces to erect 1,500 tube-wells for irrigational purposes at the expenditure of 12,000 kw to 28,000 kw, the present ultimate generating capacity of its hydro-electric scheme shows clearly how the problem of irrigation must always be the predominant partner when dealing with water and its uses in India, whereas in most countries irrigation is unimportant or is on equal terms with power. Table I shows the sceptic outlook with which the water-power development in India is treated: in spite of the fact that other countries possessing such practical potentialities were fast harnessing the aforesaid source of energy with all the latest improvements in hydraulic and electric machinery.

TABLE I.

*Hydro-Electric Works in India.*[1]

| Locality | Power installed KW or K.V.A. | Units Generated p. a. (millions) | Transmission Line—Miles | Head Feet | Province and its Probable Ordinary minimum Power in KW. |
|---|---|---|---|---|---|
| Shillong .. .. | 300 | 0·4 | ? | ? | Assam 621,100 |
| Darjeeling .. .. | 1000 | 1·6 | 3 | 275 & 650 | Bengal 1000,000 |
| Kurseong .. .. | 400 | .. | .. | ? | .. |
| Tata Power Co. .. | 109,500 | 200 | 77 | 1640 | .. |
| Tata H. E. Power Co. | 60,000 | 120 | 43 | 1725 | .. |
| Andhra Valley .. | 60,000 | 160 | 56 | 1740 | .. |
| Gokak Mills Co. .. | 1570 | 6 | ? | 210 | .. |
| Bhatghar Dam .. | 1024 | 1 | ? | 46 to 100 | Bombay 773,000 |
| Kashmir .. .. | 4000 | 2 | 54 | 390 | .. |
| Jammu .. .. | 1200 | 1 | ? | 26 | Kashmir 458,000 |
| Pykara .. .. | 23,430 | .. | 316 route miles | 3000 | .. |
| Karteri .. .. | 1000 | 2 | 3½ | 650 | .. |
| Munar .. .. | 1100 | 1·7 | ? | 380 | .. |
| Annally .. .. | 110 | 0·1 | .. | 800 | .. |
| Kotagiri .. .. | 70 | 0·1 | ? | 700 | Madras 400,000 |
| Malkhand .. .. | 250 | 0·2 | ? | 8 | N. W. F. 1000,000 |
| Uhl River .. .. | 48,000 | .. | 173 and others | 1800 | .. |
| Amritsar .. .. | 525 | 0·5 | .. | 6 to 10 | .. |
| Patiala .. . | 213 | 0·2 | .. | 8 | .. |
| Simla .. .. | 1750 | 6 | 21 | 540 | Punjab 1190,000 |
| Ganges H. E. Scheme .. | 9000 | .. | 1000 | 9–18 | .. |
| Nainital .. .. | 450 | 0·8 | .. | 1500 | .. |
| Hardwar .. .. | 450 | 0·3 | .. | .. | .. |
| Mussorie .. .. | 3750 | 3·5 | 10 | 1000 | U. P. 605,000 |
| Cauvery Falls .. .. | 37,500 | 153 | 200 | 400 | Mysore |

Though the probable reserve of Indian Coal as estimated by T. H. la Touche reaches the stupendous figure of 79,500 million tons,[2] still her immense potentialities in water-power, both intrinsically and because of the distance to which coal has to be carried are significant enough, to cause serious thought. Moreover, recent and almost revolutionary advances in the design of hydraulic turbines of the propeller type have greatly modified the whole aspect of low-fall hydro-electric schemes, another dominant factor embodied in such enterprises in India.

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1 Mears, *Water Power*, 1934.

2 T. H. Ronaldson, *Monographs on Mineral Reserves with Special Reference to Our British Empire*, John Murray, 1920.

Though, during the last decade the steam and Diesel Engines have played an important part in increasing the capacity of electric supply undertakings in this country, still the concentration on India's water-power resources are fully justified.

TABLE II.

*Indian Power Resources.*[2,3]

| WATER POWER | | COAL | | | |
|---|---|---|---|---|---|
| Probable ordinary minimum power (k-watts) | Probable maximum for development (k-watts) | Actual reserves in Tons | Output of Indian coal-fields in Tons | | |
| | | | 1916 | 1917 | 1918 |
| 7,532,000 | 12,680,000 | 4,45,833 × 1000 | 17,254,307 | 18,212,918 | 20,721,543 |

Considering the inferior nature of Indian Coal, we might take 1-hp-year as being equal to 4 tons as a fair average. On this basis the 1918 output is capable of yielding 5180385-hp-year or 3865960 kw-year, which is only about half the probable ordinary minimum available water-power out of which hardly 5% has been developed; five years back there were only Bombay and Cauvery Falls hydro-electric schemes worth the name of recording.

Till now it has been a characteristic feature of the hydro-electric power systems in India that wherever they have developed so far, the consumption *per capita* has gone up in comparison with other regions of electric power. For instance, in Bombay, which has made available the largest amount of hydro-electric energy in India, the consumption *per capita* is over 200 units.[4] In Mysore and Bangalore the Cauvery Falls Hydro-electric Scheme has made possible a consumption of about 100 units[4] *per capita*. Whereas in the cities possessing up-to-date steam power plants the consumption *per capita* is much less. Thus Calcutta, which ranks both in industrial and intellectual reputation with Bombay consumes about 110 units.[4] In Madras, which is a neighbouring city of Bangalore and the third port city of India, the consumption *per capita* is as low as 30 units[4] only. The average demand per head of population varies from 5–6 kwh in the smaller cities.

There is thus considerable market for electrical energy and if cheap power can be made available it will be readily absorbed. Of late, these expectations have been amply fulfilled by the three important provincial projects undertaken by their respective Governments, even to the extent of rendering rural electrification successful. At present owing to the encouraging demands each of these provinces have proposals on hand to develop the schemes still further.

## PROPER UTILISATION OF WATER-POWER.

With some idea of the status of water-power resources in India, we can now consider the problem of rational distribution of electrical energy as far as possible over a vast area of 4·66 million square kilometers, with its far and widely located water-power resources. Also, the Indian conditions differ materially from elsewhere, owing to her dependence on well-defined "monsoons" instead of casual rainfall all the year round. As a direct consequence of this India has one type of hydro-electric development without parallel elsewhere, namely that found in the Tata chain of schemes in the Western Ghats of Bombay. For the proper utilisation with profit an immediate and new orientation in the trend of development of transmission systems in India, is needed, most probably in the direction of increased interconnections. With the following proposed Indian super-power grid systems (Fig. 1, Map of India) it is feasible to supply economically the entire energy requirements of the country with the exception of certain restricted areas where power transmission is very difficult. These six sections of Extra High Tension lines will cover a total distance of nearly 6,000 miles. The longest of these are each nearly 1,200 miles in length, while the shortest line between Tuticorin and Madras has

[3] Mears, *Hydro-Electric Survey of India*.

[4] Basu, *Proc. World Power Conference* (held at Berlin), 1930, Vol. 10. (D. Ing. J. N. Basu of Bengal Technological Institute of Jadabpur, Bengal).

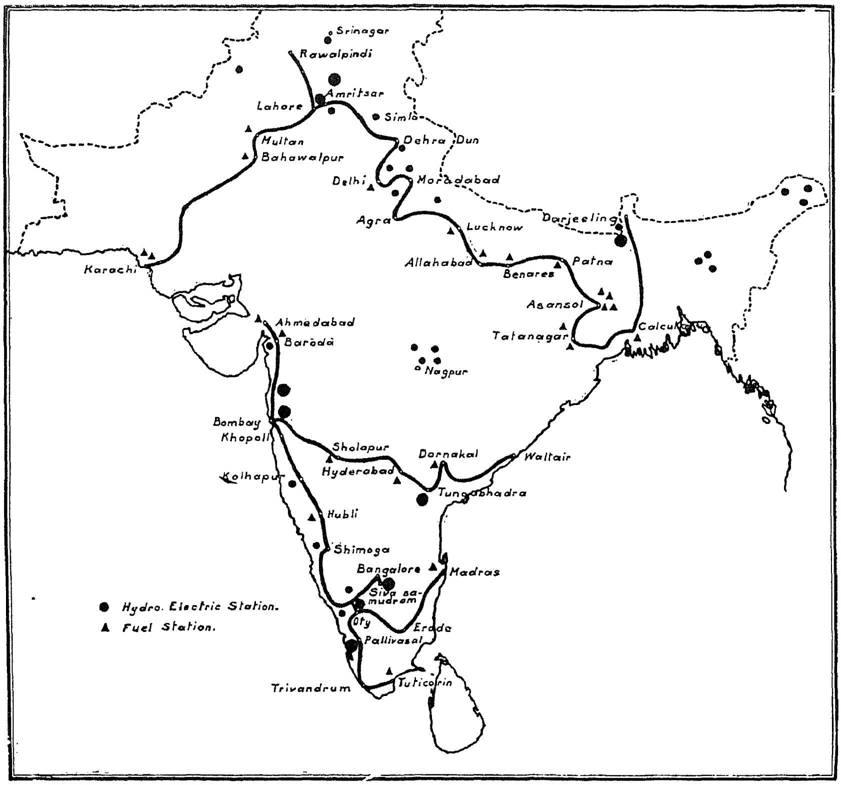


Fig. 1.

a length of 700 miles. In view of these unusual distances and vast interchange of power over such a system the minimum transmission pressure tends to increase somewhere about 400 kv. In order to secure stability in a project of such a nature, it is of vital importance to augment the power by the energy generated at the would-be super-power stations situated on the coal fields, say, for example, in Bihar Province.

As the extent and development of water-power in a country varies in accordance with topographical and climatic changes and is also affected by variations of policy in different administrations, so the first natural sequence will be the immediate formation of a Central Electricity Board of an all-India nature. It must be represented by Engineers, Industrialists and Chemists in order to prepare regular and systematic power survey reports and to investigate thoroughly the nature and extent to which the cheap electric power, thus made available, can help to create new industries. Amongst these may be mentioned (*a*) The electric smelting of indigenous iron ores and electric production of steel and alloys, (*b*) Electric welding, (*c*) The production of aluminium from the local bauxite deposits, (*d*) The manufacture of calcium carbide and its numerous derivatives, (*e*) The electrolytic production of chlorine gas and the preparation of phosphorus and of abrasives like carborundum, (*f*) Pulp and paper industry with printing, (*g*) Manufacture of electro-chemical products such as synthetic fertilisers for which there is a great demand in India, (*h*) Economical irrigation of a vast area of uncommanded land by tube-well pumping or by gravity lifts from existing canals, (*i*) Reclamation by draining water-logged lands. In addition to these attempts can be made to increase the domestic load and accelerate the electrification of Indian Railways in suburbs.

Considered from the expenditure side, the adequateness of such a scheme with a well-defined objective and policy can undoubtedly be established in its favour. For example, taking Madras Presidency, which imports coal and fuel oil (excluding petrol) worth more than Rs. 300 lakhs, a transmission network interconnecting the projects of Pykara, Perriar and Papanasam

can be provided in order to distribute 120,000 kw all over the province at an estimated total capital expenditure of Rs. 950 lakhs, provided the total fixed charges on the capital outlay of Rs. 950 lakhs does not come up to over Rs. 70 lakhs. It would be reasonable to expect that the decrease in the value of the imported fuel, on account of motive power supplanting raw fuel engines, will be in excess of these charges.[4]

In India there are several provinces (say Assam) where the demand is far less than the available supply owing to the distances of the sources from the industrial centres. The energy in such localities might be utilised with the help of chemical endothermic processes, for the production of compact materials for transportation to the industrial centres where by exothermic processes they might generate heat and power.

In India unlike in other countries it is possible to build up a load only in those places which are to be served by these super-grids after their completion. In fact the author estimates that these projects after the completion on the suggested line will be able to supply power at any point in the grid at an average price of 1 anna,* about Rs. 200 per kw-year whereas from the bulk of the smaller oil-driven plants throughout the country the rate is about 2 annas per kwh (unit). River Teesta in Bengal with a hydro-electric power generating capacity of 1,000,000 kw and River Koyna in Bombay with 250,000 H.P. need immediate attention for harnessing purposes.

### THE TREND OF TRANSMISSION PRACTICE.

With an eye to the proposal, let us examine the noteworthy advances in transmission practice which go to materialise a scheme of this character. Within the last ten years a number of 220 kv lines have been put into successful operation in different countries and this voltage has now become the standard transmission voltage for very long distances. Further to keep down the weight of copper and hence the cost of the line it was proposed at the World Power Conference in 1930 to examine the practicability of 400 kv for the operation of an European Super-power Grid of nearly 7,000 miles; and with such values of transmission distance and transmission voltage the difficulties mentioned below are introduced.

Transmission line requires excitation or charging current which varies with the load, and its supply has to be regulated by means of Synchronous Condensers. This charging current being wattless contributes towards the transmission losses, which depends upon the capacitive reactance of the line which is again proportional to the length of the line and to the frequency of the alternating current; hence it is at once seen that by reducing the frequency the power-transmitting or kilo-watt capacity of the line can be raised. By using direct current we drop the frequency to zero and it is thus that the inevitable conclusion is reached that it is the only means of increasing the transmission distance. Inductance and Capacitance vanish. The transmission line becomes stable under all possible conditions of loading and intermediate stations for compensating reactive drops become unnecessary. Apart from these advantages,

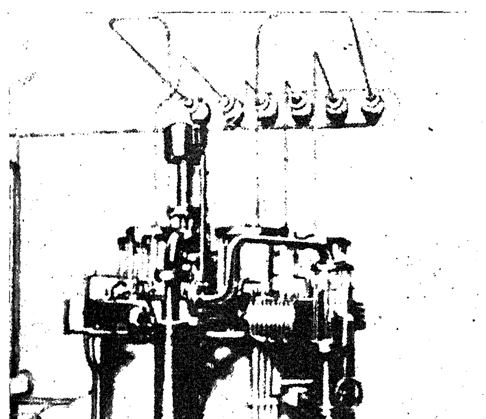

Fig. 2.

Steel tank rectifier 750 kw capacity at 15,000 volts.

the skin effect, characteristic of alternating current at high voltages is absent in the case of direct current. Corona loss with direct

[4] Basu, *Proc. Second World Power Conference*, 1930.

* 1 Rupee = 1¼*sh.* = 16 annas.

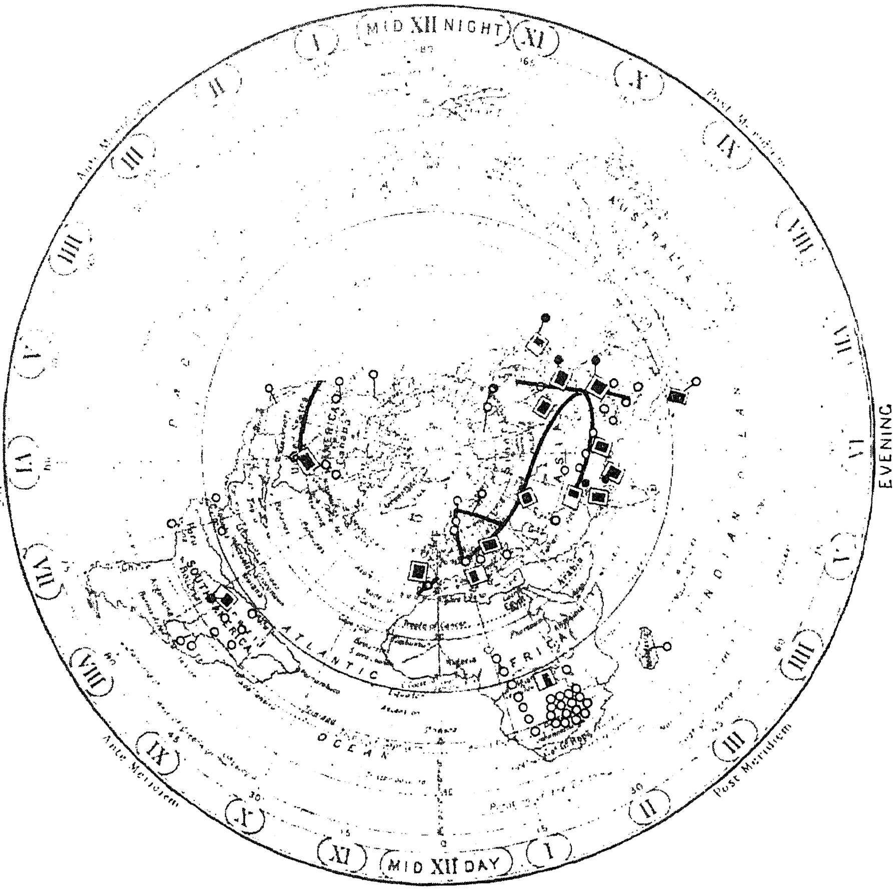


Fig. 3.

current is considerably less and for the same degree of insulation to earth the operating voltages for d.c. and 3 phase a.c. transmission are in the ratio of 65 to 23.

Even though the d.c. transmission is to form the future basis of long distance transmission, it is still essential to generate first alternating current in large high-speed machines and then to convert it to d.c. in relatively few units of efficient apparatus of static nature. It is, furthermore, equally essential that similar apparatus be employed for transforming the high tension d.c. back again to 3 phase a.c. at constant voltage for subsequent distribution throughout the existing power networks. Such apparatuses have already been manufactured on a smaller scale and are known as Rectifiers and Convertors (Fig. 2). Experimental transmission in the laboratory at 15,000 volts has very recently been achieved by the General Electrical Company of Schenectady in America for 3000 kw lines. They employed static type of Rectifiers and Convertors commercially known as Thyratron and Phanotron respectively. The efficiency of conversion with larger units under investigation are expected to be as high as 98 to 99 per cent. Thus the present double circuit line of 132 kv of the Punjab can, without further alteration, be utilised as a triple circuit direct current line operating at 370 kv between positive and negative conductors, whilst with the assumption of similar line losses in both the cases the power which can be transmitted is nearly seven times.

Besides, through the success and organised co-operation of long distance d.c. transmission we can go still a step further by interconnecting the hydro-electric and other electric systems internationally for the reduction of power cost with a more

satisfactory equalisation of load. Another method through which the equalisation of power can be attained will be to utilise the rotation of the earth. The idea behind the proposal is to get power plants which are situated at different meridian distances in an east-westerly direction to co-operate systematically. An extreme case of such co-operation would be between a power plant which is situated on the extreme east of Asia and a similar one on the extreme west of Europe (Fig. 3). These power plants should work with a day and night displacement of 12 hours, in spite of the fact that according to absolute time calculations no time displacement exists. In this way night power in the extreme west of Europe could be transferred to day power in the extreme east of Asia and *vice versa*. At present it is rather difficult to visualise so great a relative time displacement between the maximum load of similar power plants. But even with a time shift of 3 or 4 hours much can be gained, specially in electrical tramways and suburban railway services.

The exploitation of water-power resources is essential for the needs of India. However great the distances to be covered, there are no inherent difficulties from the engineering point of view that could not be surmounted. Industry and agriculture are both in need of a "grid scheme". Sooner or later the provision of a "grid" supply is inevitable, and the Government should look ahead and find the necessary capital for the scheme.

## Reviews.

NEW PATHWAYS IN SCIENCE (Based on the Messenger Lectures of 1934). By Sir Arthur Eddington. (Cambridge University Press, 1935). Pp. x+333. Price 10*s*. 6*d*. net.

Six years have elapsed since Sir Arthur Eddington's "*The Nature of the Physical World*" was published. These years have not witnessed any revolution in theoretical Physics such as that represented by the birth of quantum mechanics. The time, however, has been utilized to take stock of the implications of the new theory and much that was obscure and changing has cleared and crystallized. Sir Arthur has seized the opportunity afforded by the Messenger Lectures delivered by him in 1934 to write a sequel to '*The Nature of the Physical World*' which bears the impress of this process of taking stock. On the other hand, recent years have produced astounding discoveries in the realm of experimental physics: we have had the neutron, the positron, heavy hydrogen and induced radio-activity coming in rapid succession before our astonished gaze. These discoveries have had their repercussion on the problems of Astrophysics so near and dear to Sir Arthur. We accordingly find in the present book a portion dedicated to the consideration of the internal constitution of stars and of the expanding Universe; another part describes the philosophical outlook of modern science as Sir Arthur interprets it. The connection between the Universe of the Relativity theory and the atom of the Quantum theory which is the theme of Sir Arthur's theory of the fine structure constant is dealt with in another chapter. Incidentally we find a treatment of Probability and the Theory of Groups included. An introductory chapter will enable any one not conversant with the modern development of Physics to get a rapid acquaintance with the most recent discoveries. The subject is throughout treated in the charming pictorial style which we have come to associate with Sir Arthur. In spite of the difficult nature of some of the topics dealt with, even a layman will have a chance of understanding the direction in which modern Physics is advancing as viewed by Sir Arthur. The Indeterminacy Principle, Eddington's recondite theory of the fine structure constant, and the theory of Groups are all explained in such a lucid manner that we feel we have understood something of even these difficult matters. Sir Arthur thus provides an example of how even higher mathematics may be made intelligible to laymen.

This success in providing a popular exposition of such difficult subjects has, however, one drawback: the language is imaginative and picturesque, but the metaphorical statement sacrifices something of precision and the reader is likely to mistake a vague idea which he sometimes obtains for a profound understanding of the subject. Thus Pauli's principle that no two electrons

can have the same $n$, $l$, $(s)$, $m_l$ and $m_s$ values has been presented in the form "No two electrons may occupy the same orbit." Since $m_s$ is not connected with the orbit of the electron, we see how even a careful popular statement may lack accuracy. The same trouble arises in connection with the presentation of the philosophy of modern science: the figurative language very often confuses the thought. Sir Arthur has tried to answer such criticisms by protesting that a popular account should not be made dry-as-dust by hankering after precision. We do agree, but include a warning to the reader that he must also keep this in mind. We imagine that Sir Arthur's philosophy has been criticised by philosophers mainly as the result of misunderstanding the working convictions of a scientist for a profound philosophical system. Science does not attempt a philosophical system which can hold true for all its parts without any discrepancies. A view reached after studying a topic from a particular standpoint may not *exactly* represent the idea one gets by pursuing another subject by a method appropriate to the latter. If it has been shown that according to present theoretical possibilities of refinement in measurement in Physics, a certain amount of uncertainty necessarily attaches to the simultaneous values of two conjugate quantities, we can only say that Physics has for the present to be satisfied with a theory which tolerates and takes into account this uncertainty. But we cannot lay it down as a philosophical dogma that indeterminacy is at the bottom of modern scientific method. If we express the law of causality in the form that the same set of circumstances always produce the same phenomena, we see that the principle is the basis of all science. We may doubt our ability to produce the same circumstances or to be sure of their sameness when they are produced. Thus in radio-activity we cannot say which of two apparently similar atoms will explode next because we have no detailed knowledge of the real difference between them. But if we doubt whether the same results will always follow when *all* the conditions are theoretically supposed to be fulfilled, science and particularly experimental science would be at an end. This is the aspect which Planck and Einstein have stressed and Silberstein has elucidated in his book on causality. Whenever circumstances which are apparently the same produce different results, we try to find out what other circumstance we have omitted to take into consideration and which was responsible for the difference in the results. Modern physical theory may not be able to rise above the uncertainty involved in the methods of measurement it can contemplate. It is therefore profitable to recognize this uncertainty, but it would seem as if a belief in the principle of causality was the driving force at the back of the never-ending striving after new knowledge. Since as Sir Arthur pertinently points out, science is not wedded to one self-consistent and immutable philosophical system, we may possibly add that it is fruitless to consider either the principle of causality or that of uncertainty as a philosophical dogma. Let us however employ the one as a working principle without being blind to the existence of the other in modern Physical theory. Sir Arthur has tried to show that adherence to the principle of causality is not demanded by modern Physics; but it may not be opportune to give up a principle which has been the basis of all scientific development, particularly since there is nothing in Physics which demands its sacrifice. A perusal of Sir Arthur's replies to his philosopher critics shows that he has taken his stand as a man of science to whom philosophical consistency is not the main consideration. If this point is grasped there is no necessity for any criticism regarding his having stated his convictions not always in the same terms. We do not profess to have penetrated the mystery underlying his theory of the fine structure constant, but recent discussions of the accuracy of grating measurements of X-ray wave lengths show that the experimental value of that constant is quite near the figure demanded by his theory and even the small discrepancy which remained appears now to vanish. Under these circumstances, we welcome the lucid exposition of the idea behind the formidable mathematics of his theory. And though one may not see eye to eye with the author in all that he says, one must welcome the appearance of such an able account of present-day problems and must recognize the not very common success with which abstruse subjects have been made intelligible to the common understanding.

T. S. S.

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**Grains de Matière et de Lumière: Première Partie: Existence des Grains**

(12 fr.); DEUXIÉME PARTIE: STRUCTURE DES ATOMES (14 fr.); TROISIÉME PARTIE: NOYAUX DES ATOMES (7 fr.); QUATRIÉME PARTIE: TRANSMUTATIONS PROVOQUÉES (12 fr.). By Jean Perrin. (ACTUALITÉS SCIENTIFIQUES ET INDUSTRIELLES, Nos. 190, 191, 192 and 193. Hermann et Cie, Paris, 1935.)

All who have been charmed by the vivacious style and the beautifully clear exposition of Perrin's "Atoms" will welcome these monographs by the same master hand. There is the same verve and elegant presentation undiminished by the passage of years. It is interesting to learn incidentally from these books the part played by Perrin in the modern development of Physics. The first two parts contain an account of the structure of atoms and molecules presented in a fresh and logical manner without any mathematical details but including the results of mathematical arguments. The third gives an account of radioactivity while the fourth discusses the modern discoveries of the neutron, positron, heavy hydrogen and artificial radioactivity and the implication of these in the structure of nuclei. The treatment throughout the four monographs is from a modern viewpoint, the old problems being organically connected with the latest results. Towards the close are some interesting speculations about the structure of neutrons, protons and nuclei and the origin of cosmic rays. There is unfortunately a larger number of misprints than we should like to see. There are also one or two mis-statements such as the one which ascribes Compton's discovery to the year 1925 or which says that the atomic number of Pt is 77. These are, however, very minor matters. The fresh and unified presentation of the old and the new can elicit nothing but admiration; the range of topics includes the latest developments which cannot yet be found in any text-book. The books will no doubt thrill all readers into enthusiasm for the subject they treat and we heartily recommend them to scientific workers and lay readers alike.

T. S. S.

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AU DELA DE L'ÉLECTRON. By Sir J. J. Thomson, O.M., F.R.S. Translated by R. Fric. (ACTUALITÉS SCIENTIFIQUES ET INDUSTRIELLES, No. 211. Hermann et Cie, Paris, 1935.) Price 7 fr.

This is a translation of Sir J. J. Thomson's "Beyond the Electron" with a preface by M. A. Cotton. It is befitting that the discoverer of the electron should also try to give us a picture of its constitution. Until recently the electron played a rôle only as a point charge but modern developments have made it necessary to probe into its structure. Though giving only a partial explanation, Sir J. J. Thomson's attempt to deduce the properties of the electron from a hypothetical structure is very interesting. The wave-like and particle-like natures of the electron are made to appear as necessary concomitants of its structure: the electron is supposed to have a double structure, one part consisting of lines of force where the energy is localised, and the other a train of waves in resonance with this and determining its trajectory. In this respect the electron appears to be somewhat similar to the wave-packet assumed by Sir J. J. Thomson in his theory of light. The mechanical and magnetic moments of the electron, however, do not follow from the theory, while the success of Dirac's theory was due to its explanation of just these properties. Now that Born and Infeld's theory of the electron as a singularity in the field appears so successful, it is very profitable to see how much a less formal and more intuitional conception can explain. As a contribution to this end, Sir J. J. Thomson's monograph deserves careful perusal and the present French translation will no doubt serve to draw more attention to this interesting attempt of Sir J. J. Thomson to extend classical ideas so as to furnish an answer to some of the questions which have so far found only a quantum-mechanical treatment.

T. S. S.

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PRACTICAL SOLUTION OF TORSIONAL VIBRATION PROBLEMS. By W. Ker Wilson. (Messrs. Chapman & Hall, London, 1935.) Pp. 438. Price 25*s*.

The practical experience gained by the author for several years in carrying out investigations on torsional vibration in different types of installations has been set forth in this book in a manner suitable for everyday reference. Those that are engaged in the design of high-speed engines, turbines, turbo-generators, internal combustion engines, marine installations, etc., will find the book extremely useful as the author has tackled every conceivable problem connected with their torsional vibrations. Every case discussed theoretically has been illustrated with an actual numerical example from practice and this feature adds to the value of the book a good deal.

Starting with the fundamental definitions, the natural frequency of torsional vibrations, position of nodes, and relative amplitudes for one, two, three, and multi-mass systems are calculated in the first chapter. The method of tabulating these results, taking as examples four typical engine aggregates, *viz.*, two types of direct-coupled generator and two types of marine installation, and the interesting deductions from these results, occupy a major portion of the second chapter and they are of immense value to the designing engineer and the draftsman. Practical method of tuning the oscillating system of a direct-coupled generator and the shaft system of a marine installation to produce a favourable disposition of critical speeds, are also given in the same chapter.

The oscillating systems of actual installations are, however, much more complex than the ideal systems usually discussed in books, and with a view to assist the designer in his attempt to reduce any system to the standard one, a fairly big chapter has been devoted to the calculation of equivalent masses, equivalent elasticities and equivalent systems. The determination of stresses due to torsional vibration at non-resonant speeds, phase and vector diagrams for multi-cylinder engines, stress diagrams and calculation of dynamic magnifiers are spread over two chapters and typical examples taken from Electrical Engineering and Marine Engineering practice, have been worked out.

Accurate measurements of torsional vibration amplitudes under service conditions have to be made to enable theoretical calculations to be checked and reliable damping factors to be established. The author has therefore given a full description and the method of using (1) the Geiger Torsiograph, (2) the D. V. L. (Deutschen Versuchsaustalt fur Luft fahrt) Torsiograph, (3) Rotational Decelerometer, and (4) Electro-Photographic Vibration Recorder. Torsiograph records for various engines have been given and the actual values obtained from these curves have been compared with the figures obtained from theory and any difference is accounted for.

In certain cases the natural frequency can be modified so as to secure a safe working speed range and for this four important methods are thoroughly discussed in a chapter. The amplitude of torsional vibration can be reduced by altering the position of the critical speed (1) by altering the torsional rigidity of the shafting, (2) by modifying the dimensions and distributi of the attached masses, (3) by elastical connecting a supplementary mass to t main system at a point remote from t nodes, so that the natural frequency of t added system is equal to that of the origin system, and (4) by addition of supplementa mass at a point remote from the node an connecting it to the main system so th there is a periodic variation of natur frequency or an automatic change of natur frequency at critical speeds.

Alternatively, frictional damping device or alteration of firing order, can be use

The last chapter deals with the dynam characteristics of electrical generating se direct-coupled to internal combustion en gines. Among other things, the procedu indicated for obtaining the flywheel effe necessary for the satisfactory operation o parallel running alternators driven by inter nal combustion engines, is particularly in teresting.

On the whole, the book is as eminentl practical as it is theoretical and a very usefu addition to any Engineering Library.

In future editions, the explanation of al the notations might with advantage be given at the beginning of the book, instead o repeating them in each chapter, and als the numbering of all the equations in th book may be made continuous instead o according to chapter.

E. K. RAMASWAMI.

* * *

THE PRINCIPLES OF ELECTRIC POWER TRANSMISSION BY ALTERNATING CURRENTS. (Third Edition.) By H. Waddicor, A.M.I.E.E. (Chapman & Hall, Ltd., 1935.) Pp. 419. Price 21*s.* net.

This publication is a revised and enlarged edition of the standard book on Power Transmission familiar to Engineers and Engineering students and is very useful for any Technical Laboratory.

The author has collected valuable information from a large volume of literature published from time to time including several standard publications of manufacturing firms of repute and given a systematic exposition of the principles of design of transmission lines and a comprehensive list of valuable references for the investigator and teacher.

The economic and fundamental electrical principles are treated in separate chapters and the calculations concerned are carefully worked out. The performances of short and long transmission lines are treated

separately with graphical and diagrammatic illustrations of the standard type. The various points of design and manufacture of conductors, supporting structures and insulating materials for overhead lines are treated in separate chapters, with full discussion of the various standard designs and their adoptability under different conditions. Voltage control by phase modifiers and prevention of dangerous currents are ably dealt with giving details and wiring diagrams of apparatus employed.

The chapter on underground cables deals in great detail with all the aspects of power transmission through underground cables and the latest developments in the design and manufacture of High Tension cables have been thoroughly discussed with very neat illustrations.

Pressure rises and protection against abnormal pressure rises is very well written and the practical Engineer as well as the teacher will find the book very interesting and useful.

R. P.

* * *

EXPERIMENTAL PHYSICAL CHEMISTRY (Second Edition). By Farrington Daniels, J. Howard-Mathews and John Warren Williams. (McGraw-Hill Book Company, Inc., New York and London, 1934.) Pp. xix+499, 140 Figs. Price 21*s*. net.

In this new edition, the general arrangement of the first impression has been retained. Part I which provides a laboratory manual stands greatly altered in that sixteen of the less satisfactory experiments have been omitted and nine new ones have been added. Amongst the additions are experiments on: molecular films on liquids, electrokinetic phenomena, distribution of particle size in an emulsion, the dilatometer in the study of reaction rates, galvanic cells with and without transference, the glass electrode, the heterodyne beat method for dielectric capacity and heavy hydrogen. In several of the exercises retained the experimental technique has been modified with a view to secure higher accuracy. Part II (which deals with apparatus found most suitable for advanced work or research on topics dealt with in Part I) has been slightly amplified with a view to keep pace with recent literature by addition of topics such as Heyrovsky's polarograph, Raman spectrum, vapour density balance, high vacuum technique, etc. The chapters on photochemistry and capacity have been considerably amplified. Part III dealing with miscellaneous operations has been extended to include chapters on vacuum tubes and errors of measurement. One who goes through the book is greatly impressed by the number and variety of exercises and the adequate theoretical background for each of them. In view of the profuseness of the material it is to be regretted that no reference is made to the following: McBain's quartz spring balance (useful in studying solid-vapour equilibria), the determination of the thermal conductivity of gases and the construction of precision air thermostats. The importance of corrections (as determined by Harkins and co-workers) in the "ring" and the "drop weight" methods of determining surface tension could have been pointed out with advantage. In spite of these minor omissions the book would be highly useful to students as well as teachers.

K. S. GURURAJA DOSS.

* * *

THE GEOLOGY AND MINERAL RESOURCES OF BURMA. By Dr. H. L. Chhibber, Ph.D., D.Sc., F.G.S., F.R.G.S. (Macmillan & Co., Ltd.) Vol. 1, Geology of Burma, pp. xxviii+530. Price 30*s*. net. Vol. 2, Mineral Resources, pp. xv+309. Price 18*s*. net.

The two volumes before us constitute a substantial contribution to our knowledge of the geology and mineral resources of Burma, a country which is so aptly described as "still a land of the future." Almost immediately after he entered on the teaching staff of the newly formed Department of Geology in the University of Rangoon under the direction of Dr. L. Dudley Stamp in the year 1924, Dr. Chhibber realised the need for a decent and comprehensive manual on the Geology of Burma, and soon resolved to supply this want himself. During the next few years he deliberately set out to qualify himself by travel, field work, and laboratory study for the efficient execution of this task; and the books now under review are the result of these labours. As Dr. L. Dudley Stamp says in his appreciative Foreword, these two volumes by Dr. Chhibber "represent a valuable combination of personal research and field work and a minute and critical examination of existing literature" on the geology and mineral resources of Burma.

Vol. 1 deals with the geology of Burma and is made up of 34 chapters covering about 500 pages in all. A few of these chapters have been written in collaboration with Mr. R. Ramamirtham of the Geology

Department, University College, Rangoon. The first 9 chapters deal with such aspects of general geology as River systems, Lakes, Earthquakes, Mud volcanoes, Denudation, etc. The next 17 chapters are devoted to the stratigraphy of Burma and contain a detailed and connected account of the constitution, classification, and characteristic fossils of the different rock formations in their stratigraphical order. The palæontological portions of these chapters have been read through and revised by such eminent palæontologists as Prof. A. Morley Davies and Dr. F. R. Cowper Reed. The remaining 8 chapters deal with an intensive study of igneous activity in Burma under such aspects as its relation to tectonics, variation in time and space, variation diagrams, etc. and in writing these the author has had the valuable criticism and guidance of such well-known petrologists like Prof. P. G. H. Boswell, Prof. A. Brammal and Dr. G. W. Tyrrell. The book concludes with two valuable appendices on the correlation of the geology of Burma with that of Malaya and Assam, the former by Mr. J. B. Scrivenor, late Director of the Geological Survey Department, Federated Malay States, and the latter by Mr. P. Evans, Geologist of the Burma Oil Co., Assam.

The second volume on the mineral resources of Burma is much smaller than the first and has about 300 pages, divided into 16 chapters dealing with the various kinds of deposits of economic value found in Burma—ranging from gem stones like ruby and sapphire to soils, road-stones, and building materials. Under each type of mineral deposit, an account of its geological and geographical distribution, and present methods of exploitation have been given, together with chemical analyses, statistics of production, etc. In a few cases valuable suggestions have also been made regarding the future development of some of these mineral deposits. In writing some of these chapters, the author has wisely taken the assistance of several competent men, and thus has secured a certain amount of authority for his work. For instance, the chapter on Petroleum is wholly written by Dr. L. Dudley Stamp; many of the statements made in the chapter on Salt have had the approval of Mr. E. G. Robertson, Chief Collector of Salt Revenue, Burma; and the chapter on Soils has been written in collaboration with Mr. S. P. Aiyar of the Burma Agricultural Service. It is well known that from the point of view of mineral resources, Burma is undoubtedly the most important province of the Indian Empire; and we have no doubt that the present volume by Dr. Chhibber will be of great assistance to all those who are interested in the development of these mineral resources.

In both the volumes under review, at the end of each chapter numerous references to original papers have been given; and a perusal of the complete list of such references is enough to impress us with the extent and volume of library work which the author must have done in writing these volumes. With the subject-matter so nicely arranged and classified, and aided by the numerous and excellent illustrations so well reproduced, we have no doubt that Dr. Chhibber's volumes will long remain as valuable books of reference for those interested in any aspect of the geology of Burma.

On reading through the two volumes, we are, however, inclined to make a few observations by way of comment. In Vol. I we think that a good bit of the information of the kind given in the first 9 chapters, though interesting, is hardly necessary in a book of this kind, and might well have been cut out, thus reducing the entire matter to about half its present size, without in any way sacrificing the value of these chapters as an introduction to the study of the geology of Burma. It is also difficult to appreciate the propriety of such an intensive treatment of the igneous rocks of Burma as is embodied in chapters XXVIII to XXXIII. While we have no doubt that the information given in these chapters is of the most valuable kind, we still feel that such a detailed study dealing with igneous petrography and petrogenesis—though it be all relating to the rock types from Burma—has hardly a place in a book like this devoted to a general study of the geology of Burma. If however it is considered desirable or necessary by the author, to include these chapters for the sake of completeness, we might well ask why the same treatment should not also have been extended to the sedimentary and metamorphic rocks? With these concluding chapters in Vol. I very much abridged, and with a certain amount of general trimming in Vol. II in places where the present methods of mining etc., have been described in much too great a detail, we think it should have been possible for the author to achieve his original intention to cover in *one* volume both the geology and the mineral resources

of Burma; and this, we feel, would have been better.

In both the volumes again, we regret to see certain features in expression which are usually considered undesirable. For instance, in Vol. I, almost within a page or two, we see one and the same person variously referred to as "Stamp", "Dr. Stamp", "L. D. Stamp", "Dr. L. D. Stamp", and "Dr. L. Dudley Stamp". A locality is spelt "Nwetaung" in one place and "Ngwetaung" in another. In mentioning the fossils of the different strata, there is no consistency in the classification adopted. In one place (p. 150) Mollusca is considered as a unit of the same status as Hydrozoa or Anthozoa; while in another (p. 142) the name Mollusca does not appear but the three different classes of this phylum—Pelecypoda, Gastropoda, and Cephalopoda have been mentioned individually and each given the same status as the term Mollusca on page 150. On page 173 one cannot see why the phylum Arthropoda should come in between Pelecypoda and Cephalopoda; and on page 226 the term "Pelecypoda" which has been used so far is suddenly dropped and we get the term, "Lamellibranchiata" instead. Similarly in mentioning the different species of a genus, no consistent procedure is adopted. In one place it is *Rafinesquina imbrex* and *subdeltoidea*; in another place it is *Orthis irravadica, Orthis chaungzonensis, Orthis subcrateroides*; and in a third place it is *Productus cora, P. cylindricus, P. gratiosus.*

There are also quite a large number of passages in both the volumes where it is difficult to understand exactly what the author means, where the construction of the sentences is rather loose and not altogether happy, or where the idea expressed is much too common place to be seriously mentioned. A few such examples from Vol. I are given below: "Some of them (lakes) are important because amongst the sediments with which they have become filled in are minerals of value, including oil shales and lignite. In the southern parts of the Shan States, one of the lakes formed in this way still remains; this is the Inle lake." (p. 40); *Aristocystis* "is one of the peculiar fossils of the Ordovician period." (p. 138); "Besides *Camarocrinus asiaticus, Lingula quadrata, Orthis irravadica,* and *Plectambonites repanda* have been found in them." (p. 145); "But fortunately for Burma, there is within easy reach a whole series of richly fossiliferous Silurian deposits of this period with their rich faunas." (p. 149); "Out of 26 species found in the Irrawadian series, six are entirely of aquatic habit and two are semi-aquatic. Seven to nine lived chiefly in marshy swamps, while the remaining eight are identical with Indian Siwalik forms. Out of the 26 species, 11 at least are identical with the India Siwalik forms." (p. 254); "The origin of fossil wood is due to colloidal material associated with waters laying down the deposits in which it is preserved." (p. 256); "It was not until late Cretaceous or early Eocene times that the subterranean fires once more awoke to vigorous action". (p. 291): "In each case there is little remaining evidence to show the action of the igneous rock upon the soft sands and clays through which it passed, due partly to the rapid rate at which these beds are denuded, but at the same time, had these intrusives been accompanied by heat then the beds in contact would have shown some indications of metamorphism." (p. 393); "In the absence of fossils it is very difficult to announce the age of a formation." (p. 470).

In Vol. II we have: "When these mines are active Shan women wash for gold as they do at present in the jade mine area, while their male relatives work for rubies and other gem stones." (p. 14); "In places it (gabbro) is so fine grained and granulitic that, without the aid of a microscope, it is difficult to distinguish externally from basalt." (p. 38); "Quartz is visible in thin sections but is very subordinate, and the rock appears to be a quartz diorite. The felspar is very largely altered, but however plagioclase is predominant." (p. 40); "A stray labourer might search for jadeite boulders from the bed of the stream. This is a laborious task as the man has not uncommonly to stand in water, about thigh deep all the time while, as a rule, the reward of his exertions does not arrive very promptly." (p. 65); "The average double prismatic cleavage angle is 87·3, while it varies from 85·2 to 89·0, depending upon the angle at which the crystal is lying in the section." (p. 67); "It is noteworthy that in sales and valuations, prices are not mentioned openly, but are indicated by a conventional system of finger pressures under cover of a handkerchief." (p. 78); "A considerable quantity of stone is smuggled across the border in addition to the small amount officially carried over by mules, which return from Burma to Yunnan and China with the advent of the rainy season." (p. 79); "The cutting

(of jadeite) is done with steel wire; generally two of three wires are plied together. The boulder rests on a wooden frame and the saw is worked by two men sitting at either end. On one side there is a small basin containing coarse carborundum powder and water, and during cutting this moist paste is continuously poured on to the boulder by means of a long rod either by one of the workmen or by a small apprentice boy." (p. 81); "The country has undergone secular changes of depression, evidenced in the coast line and interior, followed by upheaval." (p. 177); "It (Mica) is associated in a medium grained pegmatite with a micrographic intergrowth of quartz and felspar. The author had a small pit dug to a depth of about 6 feet and found that mica continued to that depth." (p. 239); "With the invention of the internal combustion engine, it is becoming essential for the development of a rice country like Burma to possess a good system of roads, linking her main river systems with the railway terminii and sea ports." (p. 87).

In pointing out some of these irregularities in expression and in quoting at some length these examples of what appear to us as unhappy in diction, let not our intention be misunderstood. We have nothing but praise and admiration for the great trouble which Dr. Chhibber has taken in compiling these two valuable volumes; we are however anxious at the same time that in a great work of this kind produced by one of us, there should be nothing which will tend to let it down in the estimation of the scientific public in India or abroad.

L. RAMA RAO.

* * *

MANUAL ON THE AIR-SEASONING OF INDIAN TIMBERS. By S. N. Kapur, B.Sc., Ph.D. A.I.C., A.M.I.Chem.E., Officer-in-charge, Seasoning Section, Forest Research Institute, Dehra Dun. (Delhi, Manager of Publications, 1934.)

The seasoning of timber is a very important subject, which has suffered from undeserved neglect in India, considering her vast timber resources and the necessity for properly conserving them. In Europe and America, the old-fashioned method of air-seasoning has been superseded to a very large extent by the modern processes of kiln-drying. In India, however, for some reason or other, air-seasoning is the only method practised to any large extent. Even this method is not followed in an organized, scientific manner and haphazard methods of seasoning are responsible for the loss of large quantities of valuable timber. Mr. Kapur's book is therefore a very timely and useful publication.

The first part of the book is devoted to a general description of the principles and methods of seasoning timber. Among the important topics dealt with are:—Methods of Determining Moisture in Wood, Shrinkage and Moisture Relation of Wood, Mechanism of Wood-Seasoning, Seasoning Defects and their Causes, Water-Seasoning, Requirements of Air-Seasoning and Practical Methods of Stacking Timber for Seasoning. Each of the topics is briefly but very clearly dealt with and illustrated by numerous excellent plates.

The second part of the book is entirely devoted to an account of the air-seasoning characteristics of 120 of the commonest species of Indian timber. Directions about the proper methods of seasoning are given for each species. As these are mostly based on experiments by the author and his colleagues at the Forest Research Institute, they will be found very useful by all who are interested in the subject.

The printing and get-up of the book, and the illustrations are excellent. The author deserves to be congratulated for writing a very useful and instructive book on this important subject.

C. V.

## Errata.

Vol. III, No. 8, February 1935.

| *Page* | *Column* | *Line* | *Read* | *For* |
|---|---|---|---|---|
| 341 | 1 | 56 | Mergui | Murgyi |
| 343 | 2 | 9 | Adam's | Alam's |
| 344 | 2 | 7 | Uru | Uri |
| 345 | 1 | 47 | Trauth | Trouth |
| 345 | 2 | 12 | Na HKyam | Nam Hkyam |
| 345 | 2 | 13 | *Xenaspis* | *Xenorpis* |
| 345 | 2 | 19 | A new genus of the *Hungaritidæ* | The new genus *Hungoritidæ* |

951-35.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

# Current Science, Vol. III, 1934-35.

## Author Index.

## Title Index.

## Errata.

Pages 90, 180, 226, 282, 454, 588, 644.

THE BANGALORE PRESS

house or person, and procures an insufficient supply of food from the garbage of towns and villages. A misguided sentimentality prevents the destruction of these stray dogs. No other animal is as intimate psychically and physically to man as the dog. Rules and regulations to control the dog population should appeal to both dog lovers and humanitarians. The neglect of this simple remedy for such a dread disease, which is 100 per cent. fatal, reflects upon the logic and intelligence of ourselves and our contemporaries.

Registration and licensing of dogs must be enforced by all municipalities and district boards. The licensing fee must be fairly high to prevent persons who can ill-afford to keep dogs from owning them. Any person possessing a dog without a license must be heavily fined. Lethal chambers must be established for the destruction of all ownerless dogs. Clubbing, poisoning and the shooting of them in the streets are out of the question. All railway companies should make arrangements to destroy stray dogs found in railway station premises.

In rural areas, besides the destruction of stray dogs, jackals also should be destroyed, as no doubt a certain percentage of dogs get their infection from this source.

No useful purpose would be served at the present time by the quarantine of dogs imported from foreign countries, while rabies is so prevalent within the land. Only when we have perfected the system of controlling the local dog population, should attention be paid to the quarantine of imported dogs. At present, most of these dogs come from Australia and England where no rabies exists.

During recent years, almost all the Pasteur Institutes in India have been using a more concentrated vaccine for treatment. Since the introduction of the higher dosage, there is a significant fall in the mortality rate.

Anti-rabic treatment should be decentralised to the utmost extent possible, so that persons bitten by dogs could have treatment nearer their homes.

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### ANTHROPOLOGY.

*President:* DR. G. S. GHURYE, M.A., PH.D. (CANTAB.).

## ANTHROPOLOGY AND OUR EDUCATIONAL SYSTEM.

THE subject of Anthropology is still new and strange enough to evoke different reactions in the minds of different people. To the lay man it conjures up pictures of skulls and other bones, sometimes of the "weird" customs of "savage" peoples and "curious" implements of stones and bones. The explanation of this popular conception lies in the growth of this science and in the fact that it comprises three branches dealing with aspects of man's history which are not as yet properly integrated in the courses of study in Anthropology and in the practice of professed Anthropologists. Anthropologists have not paid as much attention as the importance of the subject deserves to the social and cultural history of ancient and modern civilizations. The use of this science as conceived by the great British Anthropologist Tylor assumed a very wide scope of the subject. Anthropology was to be a guide for bettering social life. To this end inclusion of a proper study of the social and cultural history of the peoples of mankind, uncivilised and civilised, past and present, is quite essential. Such a study is bound to convince people of the reality of culture-contact, and of the part such contact has played in the shaping of civilizations. That culture does not progress uniformly but shows cycles of advance and regress, that certain highly developed cultures have perished while other peoples who had but the rudiments of culture have made great progress are very important lessons for us Indians. Our younger generation imbibing these lessons will develop a correct attitude towards the situation which has arisen out of contact with Western civilization. We need not be downhearted and actuated by inferiority complex. Nor should we develop a sense of superiority and self-complacence. We have amongst us a fairly large number of primitive tribes whose assimilation in our culture is a problem of great national importance and is one which ought to be studied with the help of expert Anthropologists. Our approach to the much-needed social reforms must be changed. Instead of appealing to the old scriptures for suggested reforms we must appeal to lessons from the history of humanity. For thus only a rational attitude towards social change—a crying need for all societies—can be created. In view of the great cultural and intellectual value of Anthropology and Sociology it is earnestly suggested that these subjects should be introduced in all courses of study which are likely to be taken up by students who in their future careers will become leaders of society in one capacity or another.

* * *

### PSYCHOLOGY.

*President:* Dr. S. C. Mitra, M.A., D.Phil.

## PSYCHOLOGY AND LIFE.

PSYCHOLOGY deals with mental processes. As a natural science it has made considerable progress within the last fifty or sixty years. Investigations are not confined now to the mere academic discussions of what a feeling is, or how one remembers; but efforts are directed towards making the theoretical knowledge gained serviceable in the practical fields of life. The art of curing physical illness is considerably helped by the researches in the science of Physiology; so also the task of treating mental maladies is much facilitated by the discoveries of modern Psychology. A disease, whether physical or mental, is after all a want of proper balance. Men live in societies. A society is an organism which means that there is mental interdependence and no one can live without the help of others. Men's actions are directed towards maintaining this harmony. A trait in a man's character becomes a diseased trait only when the presence of it leads to actions which tend to disturb this equilibrium. A diseased trait therefore may be described as not only an abnormal trait but an anti-social trait. How these anti-social traits develop in particular persons has been made clear to us by Psychoanalysis, and as knowledge is power, we are now in a better position to combat these mental diseases, which unfortunately are on the increase in many countries, our country not excepted.

Everybody recognises that proper education is one of the best methods of removing the maladjustments that we see around us everywhere. Psychology enables us to measure with some

degree of precision the innate aptitude and capacities of a boy or a girl and thus to indicate the type of education that is suited to him or her as also the avocation of life for which he or she is best fitted. A good deal of energy which is now lost in trying to fit a square peg in a round hole is thus saved.

In the spheres of Industry and Commerce, in the wider circle of international relations as also in the narrower circle of family life, psychology is capable of rendering much useful service. In our country, however, the knowledge that has been gained is running into waste for want of proper organisation. It is urgently necessary, therefore, that an Institute of Applied Psychology be founded here as early as possible whose duty it would be to undertake actual large-scale work for the benefit of society as has been done in many other countries. The problems of life in our country are no less keen and acute than in other countries, and if the utilisation of psychological knowledge has been helpful in other countries, there is no reason why such a method should not be adopted here.

## Diseases of Sugarcane.

*The Antigenic Properties of the Sugarcane Mosaic Virus.*—Dr. S. V. Desai in an interesting paper read before the Section of Agriculture of the Indian Science Congress, discusses the results of serological tests with "anti-mosaic" and "anti-healthy" juice sera. Rabbits were immunized by inoculating with increasing doses of Chamberland Candle filtrates of mosaic and healthy leaf juices intravenously. Anti-mosaic and anti-healthy juice sera were used for precipitation and other serological tests. Anti-mosaic serum inactivated the mosaic leaf juice while anti-healthy serum had no effect as was proved by inoculating ten plants with each of the sera-mosaic leaf juice mixture. All plants inoculated with anti-mosaic serum and mosaic leaf juice mixture remained quite healthy while the similar mixture with anti-healthy serum was infective to the plants inoculated. Precipitation tests with diluted sera and leaf juices showed that the anti-mosaic serum gave a positive reaction with mosaic leaf juice and negative against healthy leaf juice. Anti-healthy, however, gave positive reaction for both leaf juices, though the reaction was faint in both the cases. This may be due to the antigenic properties of the plant protein present in the leaf juice used for immunizing the rabbits. The plant juices used as antigen did not give Millon's, Biuret and other protein reactions. The nitrogen in the juices was found to be ·01 per cent.

*A New Disease of Sugarcane.*—Dr. Desai has recorded his observations on *a disease of sugarcane* observed at Musheri Sugarcane Research Station. The symptoms of the disease were wilting of the canes and rotting of the plant from top downwards with a strong smell of fermenting debris. The disease appeared during monsoon, the affected plants rotted very quickly and the stem became a mass of semi-solid stinking pulp. Hence it is named 'Stinking rot'. The causative organisms were isolated and studied. Two types of Bacteria were found in the affected tissues. One was pathogenic and the other saprophytic but the mixed cultures were found to be much more effective in bringing about the disease by artificial inoculation.

Biochemical and cultural reactions of the pathogenic organisms were allied to organisms of the Pyocyaneus group but differed from *Phy. Xanthochlorum*, *B. Aptatum* and *B. Marginale*, which represent the allied pathogenic types of this group.

The organisms were non-pathogenic to potato, beans, tomato, tobacco, and other plants tried. The pathogenicity was only confined to sugarcane. The infection in plants is supposed to be through top shoot borer holes. The 'dead heart' formed a suitable medium for mass development which initiated vigorous rotting, some plants being killed within a fortnight.

## A Biologist's Philosophy of Life.

A Biologist is proud of the achievements of science, but humble before the mysteries of nature. He respects truth more than authority. He rates evidence above theory, but nevertheless attempts to progress by the use of constructive imagination. He strives to be open-minded, tolerant, critical but kindly, courageous but cautious. He looks forward cheerfully to a life of hard work and expects to be methodical, painstaking, accurate, persevering—and modest because he believes that his profession is most honourable and that his own carefully-considered endeavour is worth while. He feels an obligation to keep alive by study, discussion and thought. If he attains honour, he has ideals, ambition, wit and common sense and is somewhat a gentleman of culture. Like any man he needs an avocation, but he must seriously attend to his business in life and plan to be the best possible in his chosen field—industrious, well informed, thoroughly trained, alert and active; a swimmer and not a floater.

A biologist thoughtfully chooses a field in which he can raise problems. He fertilizes his plots with carefully tested mixtures of thought, knowledge gleaned from books and journals, suggestions from colleagues, and eternal painstaking. He waters them with the sweat of his brow. When some of his cherished projects flower and bear fruit, he is glad—and writes a paper or discourses. Perhaps his friends say, "It is good. This man has added to the sum of knowledge. Up and on!" This is his reward.—DR. ARTHUR SPERRY PEARSE.

# SUPPLEMENT TO "CURRENT SCIENCE".

## Energy and Economics.

By Gilbert J. Fowler, D.Sc., F.I.C., F.R.San.I.

AT the close of a lively discussion on what has now come to be known as the "new economics", which was reported at length in the *Madras Mail* of December 10th, 1932, the following question was asked—"How can a thing the supply of which is infinite have any economic value at all? And, how can anything which has no economic value be used as a standard of value?" The reply was a further question—"You see that ray of sunshine. What is its value?" Reply—"I do not know" (Laughter). Counter reply, "Nor do I" (roars of laughter). "But that does not make it valueless!" (Renewed laughter).

This entertaining episode awakened numerous "pensees d'escalier" in the mind of the present writer, and some of them, after the passage of two years, and careful watching of the intervening trend of things, find expression in the present article.

In the first place one ray of sunlight, falling upon a photo electric cell could cause a flow of current which could operate dangerously or usefully according to the character of the mind by which it was controlled. Thus the energy from the far star which was made to set in motion the mechanism which opened the Chicago Exhibition, might equally have been the means of firing a mine. In either case the amount of energy expended is perfectly measurable.

Of greater fundamental importance is the fact that such a ray of sunlight falling upon a green plant cell liberates biotic energy, and the plant *grows*. It is estimated that with the assistance of solar energy plants convert per year 60 billion kilograms of carbon dioxide into useful organic substances. Even so only one ten thousandth part of the total solar energy received on the surface of the earth is thus utilized. Moreover this enormous photosynthetic activity is capable of being doubled if caused to act intermittently with a sufficiently rapid alternation of light and dark periods.

It must be remembered further that it is solar energy which lifts the water of the seas and brings it down as rain, which by the labour of man, itself derived from the energy of sun-raised food, can be stored and used to give life to the growing crop, and to turn the turbines through which the solar energy reappears as mechanical and electrical power.

Although therefore the supply of solar energy is virtually infinite, its value cannot be denied.

It has been calculated indeed, on the basis of figures given by Sir James Jeans, concerning the weight and value of *photons*, that we are actually receiving £50,000,000,000,000 worth of sunlight a day. The earth takes delivery from the sun of about 160 tons of sunlight a day and a pound of sunlight if supplied through a meter in the manner of electrical energy would cost £100,000,000. The only manner of utilizing the sun's rays directly so far has been in the form of heat, and great improvements have recently been made in sunshine boilers and furnaces. The schemes which have been undertaken with the object of using the heat of the surface water of tropical seas by heat exchange with the cooler water of the depths, have not so far been reported as successful, owing to some unforeseen mechanical difficulties, but such a process is not inherently impracticable and ultimately may lead to a further increase of the enormous store of energy available to the modern world.

That energy can be used as a *measure* of value is clear from the fact that the kilowatt hour, the unit of electrical energy, has been used successfully by The Victoria Falls and Transvaal Power Company as the unit of their accountancy for nearly a quarter of a century.

There would seem to be, as often happens in discussion of economic questions, some confusion of terms in the question referred to at the outset of this article. When the questioner asked whether anything, the supply of which was infinite, could have any economic value at all, what may have been in his mind was not value but *profit*, which is quite a different thing.

On the occasion of the miracle of the loaves and fishes, when it is recorded that all had enough and to spare, since several baskets of fragments were collected after

the repast, there was *value* there for every hungry mouth, but the only way in which there could be any individual *profit* would have been if certain "rugged individualists" had rushed the camp and held up supplies until they had obtained their *price*.

Objection may also be taken to the term *standard of value*. Value fluctuates with circumstance and desire. Jewels once highly prized become unfashionable, and the price sinks to a small percentage of the original, though the jewels are unchanged. A perfume once plentiful becomes, through some change in natural conditions, very scarce, and consequently increasingly valuable. Such fluctuations can however be met without dislocation of the economic system if the token or *basis* of value remains unchanged. If however the buyer, *e.g.*, of the depreciated jewellery undertakes to buy it for so many rupees and the seller sends a bill in which the rupees figure as pounds there can be no reasonable business. Or if goods are invoiced by the Bombay Maund (28 lbs.) and paid for as so many Bengal Maunds (74 lbs.) there must be trouble.

A fixed basis of *accountancy* is therefore necessary and this cannot be found in a commodity the value and quantity of which is constantly varying. It is as if travellers having made arrangements for their journey on the basis of the fares given in the company's timetables, were to find either that there were no tickets to be had, or that the price had greatly increased, owing to the scarcity of the paper of which the tickets were made, though all the time the train was awaiting them with plenty of accommodation.

Such a procedure would be equivalent to cornering theatre tickets while the house was only half full and there was a long waiting queue outside. This operation is said to be a criminal offence in Mexico.

The confusion therefore in the discussion with which this article opens is between *money* and *wealth*, and also between *value* and *profit*.

The connotations of these words like many other words concerned with fundamental conceptions, have varied through the ages according to the level of perception reached by the thinkers of the time.

According to Prescott (*History of the Conquest of Peru*), the ancient Incas would have seemed to have reached a higher level of understanding than their Spanish conquerors. In the first place they realized the fundamental importance of agriculture. Every man, except the privileged classes, was required to assist in the cultivation of the land. The Inca himself did not disdain to set the example. On one of the great annual festivals he proceeded to the environs of Cuzco, attended by his court, and in the presence of all the people turned up the earth with a golden plough, thus consecrating the occupation of the husbandman as one worthy to be followed by the Children of the Sun. One cannot help but be reminded of Il Duce, who in similar, but more homely and democratic manner, has encouraged the Italian cultivators.

Gold in the Inca economy was valued for its beauty, it was not used as money but was lavishly employed to decorate the Temple of the Sun, and marvellous workmanship was displayed in these adornments. This workmanship was lost upon the Spanish conquerors who caused the Indian goldsmiths to melt down the work of their own hands into bars of gold. At the sack of Cuzco, Prescott writes: "Every article rose in value as gold and silver the representatives of all declined. Gold and silver in short seemed to be the only things in Cuzco that were not wealth."

This vandalism has alas not been confined to the Spanish conquerors. In the exceedingly interesting Supplement on Gold published by the *Times* in June 1933, it is stated that the exquisite work of early goldsmiths is now very rare, owing to the majority of the pieces having been melted down for bullion by various warring armies. Possibly some of these ravages may have been present in the mind of Milton in his description of Mammon.

"*Mammon*, the least erected Spirit that fell
From heav'n, for ev'n in heav'n his looks and thoughts
Were always downward bent, admiring more
The riches of Heav'n's pavement, trod'n Gold,
Than aught divine or holy else enjoy'd
In vision beatific."

The words of Prescott concerning the Spaniards in this connection, are also worthy to be quoted: "The wealth thus suddenly acquired, by diverting them from the slow but surer and more permanent sources of national prosperity, has in the end glided from their grasp, and left them among the poorest of the nations of Christendom."

There would seem to be an analogy between the ideas of wealth entertained before the days of Adam Smith, and the ruling notions of the scientific world before

the time of Dalton and Joule. To consider wealth as gold, resembles the thought of heat as *caloric*, a definite substance. The present writer derived his early ideas of energy from Tyndall's classic volume "Heat a Mode of Motion", a title which indicated that such a conception of heat was still by no means universal. It is little more than a century ago that terms such as *phlogiston* and *caloric* were current in scientific literature. They belong to the same static sense of things as is expressed in the "wages fund" theory of Bentham and others, so caustically criticised by Karl Marx. Marx himself however appears to argue that the "Value" of commodities depends exclusively upon the amount of labour involved in their production, and he goes on to contend that the labourer produces more than is necessary for his subsistence, and that the rest of his product passes to the capitalist, who has bought his labour power for a subsistence wage. This is his main charge against the capitalist system, that while it encourages production, the profit of the production goes to the capitalist and not to the workmen. Unfortunately economic history has largely confirmed the conclusion of Marx. The proof of this is a simple matter of statistics. Thus in the 1911 edition of Chiozza Money's "Riches and Poverty", the following data are given: Taking figures for 1900 as 100, by 1908 wages have only risen to 101 nominal, an actual drop in real value, whereas profits have gone up to 112½. Between 1893 and 1908 nominal wages increased by 12 per cent. and profits by only ½ per cent. short of 30 per cent. which means that the capitalist has managed to get approximately two and a half times the nominal increase of the workman's takings, and in real values to get all, or more than all, of whatever increase may have been harvested.

It is over Marx's proposed remedy, namely, the Dictatorship of the Proletariat, or of the working classes, that there is room for serious discussion. After all, it is President Roosevelt who says, "I do not believe that in the name of that sacred word, individualism, a few powerful interests should be permitted to make industrial cannon-fodder of the lives of half the population of the United States."

Henry George looked upon *land* as a fundamental factor of production and believed that if the possession and control of land could be in the hands of the people, *i.e.*, the State, it would be the cure for economic troubles. Without "a man to till the ground," land in itself has, however, little value as wealth. Marx's workmen without the assistance of the machine, itself driven by solar energy, either conserved in coal, or collected in the turbine, can accomplish little, but on the other hand, energy, without direction by intelligence, is a blind force.

It has been said that if only one sentence remained of his writings still Ruskin must be recorded as a prophet: the sentence is:

*There is no Wealth but Life.*

Through the intelligence exercised by man the infinite stores of energy can be utilized to attain almost any possible development. This is the world to which we are rapidly approaching and it is surely for the scientifically minded to take their share in thinking out the implications of this new order of things, lest imperfect knowledge, spreading down to the proletariat of Marx, should prematurely light the fires of desperation, and the power, which might result in a full and happy life for all, should be short circuited into a useless conflagration.

It is of value therefore to consider how the coming civilization of plenty will deal with economic methods which are accepted in an age of scarcity, how the concepts of a static world must be modified to meet the problems of an essentially kinetic civilization.

It is unfortunate that the scientifically minded are generally so busy with their own affairs that they have no time carefully to consider matters of possibly wider human interest, while those who really do control finance and politics, which directly affect the life of the ordinary citizen, are themselves largely "flat earth philosophers", and have little conception of the real forces at work in the real world.

It may be hoped that the efforts of the British Science Guild and the Parliamentary Science Committee under the guidance of Sir Albert Howard may be the means of bringing some light into this political and financial darkness.

In the remainder of this article an attempt will be made to visualize the implications of the concept of energy as applied to the present social economy.

It will be necessary to consider its effect upon present ideas of *Capital*, of *Interest* and of *Currency* and afterwards, to determine how far mankind is ready to accept such a new point of view. Finally reference will be made to a suggested experimental method

for trying out these new conceptions before the possible advent of a general revolution.

Capital.

Capital is obviously stored energy. The new born child at its mother's breast exercises energy in securing its nutriment, and immediately has added to its wealth, *viz.*, its expectation of life. As time goes on its stored energy increases, until on reaching maturity it represents a serious asset to the community. It has been calculated that the worth of an American boy increases from 9333 dollars at birth to 28,654 at the age of 18. The value of an Indian cooly or even of an Indian student may not be as much as that but it must be considerable. What would be said of anyone who took bullion worth half a lakh of rupees and dropped it in the sea! There might be diving operations to recover it. But apparently little is thought of wasting millions of lives. Human sacrifice to the "Great God Waste" would appear still to be practised.

In the days of slavery owners were not so careless. Slaves at least were as well housed and fed by most of their masters as were horses and cattle. So much was this the case that in a circular sent out to the American banks in 1862 during the Civil War it was stated that "slavery is but the owning of labour and carries with it the care of the labourers, while the European plan......is that capital shall control labour by controlling wages."

Actually as Henry George pointed out: "It is from the produce of labour, not from the advances of capital that wages come."

It is evident that the labourer brings to his work his accumulated capital, *i.e.*, himself. The moment he drives his pick into the ground he has done $dw \times dt$ of work and the sum of these units, or "quanta" of productive labour increases his capital by the value of such labour. Strictly he does not need *money*. He should require only to present a work certificate to receive the *goods* which he needs, to the equivalent value.

Actually in the Indian countryside labour is largely paid in this way. A well-known Director of Agriculture once stated to the present writer that after twenty-five years experience of Indian agriculture, he could not yet state the cost of ploughing an acre of land. Labour then *is* capital and every man represents so much capital value. This is well understood in Nepal, where, according to report, careful record is kept of every individual born, each of whom is regarded as a potential asset. This brings to mind the famous statement in the "Protocols of the Learned Elders of Zion,"*

"You are aware that the gold standard has been the ruin of the States which adopted it, for it has not been able to satisfy the demands for money, the more so that we have removed gold from circulation as far as possible. With us the standard that must be introduced is the cost of working man power, whether it be reckoned in paper or in wood. We shall make the issue of money in accordance with the normal requirements of each subject adding to the quantity with every birth and subtracting with every death."

Human beings then constitute a large portion of the capital of the State, perhaps indeed the only real capital, since without inhabitants there is no real wealth.

Given human inhabitants capital at once increases, and enormously so with increase of *intelligence*. A Luther Burbank requires a much smaller area of land for comfortable subsistence than a simple ryot. Intelligence therefore is valuable capital, but its exercise depends under present life conditions on adequate food supply. Here comes in the inter-play of sun and labour and life. Again gold, or money based on gold, has little real connection with the matter.

From intelligence arises the *machine* and the application of *power*, and again potential capital is indefinitely increased. Ultimately all this capital comes as we have seen from the sun, and the life force in the growing plant. Gold and speculation would seem to have little to do with the accumulation of real capital. Speculation without industry adds nothing to real wealth, it merely transfers existing wealth from one place to another.

Modern science, then, takes us a step beyond Adam Smith or Henry George, and reveals capital as being ultimately neither labour nor land but *Energy*.

Akin to capital is *credit*. The basis of credit will vary according to our concept of capital. This again varies as has been said, according to the level of perception reached at a given time and place. From a recent conversation with an experienced Scotch banker during a train journey, it would

* In this connection it may be stated that it is of small moment whether the "Protocols" are a real document or a forgery. Men are ultimately moved by ideas rather than by persons. The ideas there expressed are evidently held by certain people in the world and the results are apparent in the recent international situation in regard to gold. By "going off gold" England escaped the threatened disaster.

seem that, as in the case of the Incas and the Spaniards, the perception level has tended to be lower in recent years than in more primitive times. In his early days, this informant related, in the little Scotch bank in which he served, the only securities or valuables committed to the bank's care were such items as old Mr. Macpherson's will or Mrs. Mackay's jewels. Now the safe is filled to bursting with "collateral" in the shape of bonds and shares of various descriptions. In the old days personal *character* was the chief basis of credit, *i.e.*, the belief in the honest activity of the individual.

Similarly in China. The simple "can do" of the Chinese merchant was at one time sufficient security without witness. A new comer, a young branch manager, lost a valuable client, and nearly his own job, through asking for signature and witness from a merchant of the old school who had come to make a deal for "luck" with the new incumbent.

Nowadays a signature and two witnesses are necessary.

Banking as another bank manager once remarked is now little more than pawnbroking—"Gif me ze votch and I gif you ze money."

A constant problem to many is why banks flourish and men decay. As a character in a recent novel by J. B. Priestley exclaims :— "Let's have some marble engineering works and gold-plated shipyards. And we'll have a dole for bankers, and see if we can't give 'em a bit more than they give us."

The coal mines and factories of Stinnes and Kreuger still function usefully, though the millions of their speculative gains have vanished. Stinnes, however, was a true internationalist. He believed that minerals, wherever taken from the earth, should be taxed for the benefit of the world, his idea being to hand over these funds to the League of Nations, or other international body for distribution to those countries requiring development. By such means also a glut of foodstuffs or other commodities in one part of the world and scarcity in another could be rectified. He mentioned, as an example, that a tax of one dollar per ton on all the coal of the world would furnish a fund of £1,000,000,000.

Coal is itself stored solar energy. Other minerals are won by expenditure of labour, dependent as has been said on sun-raised food.

Reference has already been made to the stored solar energy of impounding reservoirs and growing crops.

Capital then is *energy*, credit is *honesty*.

INTEREST.

It is becoming increasingly realised that religion reaches by intuition to facts and principles which are afterwards verified by the intellect. Such intuition indeed is not confined to what is commonly thought of as religious perception. Chemists will recollect the story of the discovery of the law of the linking of atoms, how Kekulé, meditating in a half dream consciousness, saw in his mind's eye the dancing atoms which suddenly seemed to link up, some in chains and some in rings, and how he spent the rest of the night working out the results of this vision. Later, when he was describing the experience in his address at a celebration held in his honour, he said in effect, "Let us learn to dream, but let us verify our dreams by our waking thoughts."

The question of the payment of interest on monetary loans has been the subject of pronouncement by the leaders of religion in the past, as it has again come into the foreground of religious discussion in the present.

The subject frequently recurs in the writings of the Fathers of the early Christian Church. They in fact seem to have deprecated the very idea of private possession, thus Clement of Rome writes, "It is unjust for each to speak of what is his and it is from that that comes division among men."

Ambrose of Milan writes, "Private property is an obstacle in the way of confidence and love."

It is well known that usury is strongly condemned in the *Qur'an*. "The *Qur'an* draws a distinction between trading and usury. In trade the capitalist takes the risk of loss along with the hope of profit, but in lending money on usury the whole of the loss is suffered by the man who uses his labour, whilst the capitalist may count upon his profit even in the case of loss in the actual concern." (*Extract from Commentary.*)

Here may be seen very clearly one reason why industry cannot flourish in India when it is so much easier to lend money in the bazaar at high rates of interest, which interest entails no actual labour on the lender's part, than to sweat blood in building up an industry yielding perhaps 10 per cent.

In a note entitled "The India White Paper and the Co-operative Movement," Sir Daniel Hamilton quotes Adam Smith as follows :—

"In Bengal money is frequently lent to the farmers at forty, fifty or sixty per cent. interest, and the succeeding crop is mortgaged for the payment."

Sir Daniel gives a table of money-lenders' present rates in 25 districts of Bengal. Only in one case are they as low as 10 per cent., in nine cases they are over 100 per cent., in one case reaching 300 per cent.

Put into terms of energy, loaned capital may represent water pumped by the lender into a tank. If he lends that water to a cultivator, he is entitled to the return of what he has lent, or its value at the time he lent it, but the additional value which may arise through the use of the water to drive a turbine or irrigate a crop, is due to the efforts of the borrower or from these efforts *plus* solar energy, and with all this the lender has nothing to do.

It is true that he may hold up the supply of water in order to get more for it, but this is not business but exploitation. It becomes impossible when there is ample rain or river water available, which is what will happen in the new economic system, when all sources of energy are fully utilized.

Under present conditions, moreover, if the borrower strives to pump back water into the tank he finds that the tank continually leaks and his task becomes hopeless for the tank can never be filled. There are apt to be a number of leaks in the tank but the most constant and serious is *interest*.

It is quite obvious that the continual increments of interest which accrue on a sum originally lent by the individual, cannot possibly have any relation to his own efforts.

Quoting again from the "Protocols", speaking of Government Loans :—

"If the loan bears a charge of 5 per cent. then in twenty years the State vainly pays away in interest a sum equal to the loan borrowed, in forty years it is paying a double sum, in sixty treble and all the while the debt remains an unpaid debt."

A striking example of debt increase is given in Walter Jones' "Capital and Labour" (P. S. King & Son).* To emphasise the difference between earning and investing the author states that if Judas Iscariot had started 1,900 years ago, and put aside £10 per week, he would not have been a millionaire to-day :

$$52 \text{ weeks} \times 10 \times 1{,}900 = £988{,}000.$$

If instead of earning, he had invested one penny only at 5 per cent. compound interest, it would during the same period have accumulated to eight sextillions of pounds, approximately :

£8,000000,000000,000000,000000,000000,000000

and, incredible as it may appear, it would require 3,000,000,000 globes of solid gold the size of this earth to pay him in cash.

It is not difficult to see, in the light of such an illustration as this, why the whole of the world under the present system of loans on interest finds itself slave to the banker, and the only outcome must be war or repudiation.

There was wisdom in the idea of the Sabbatical and Jubilee years of the ancient Jews. (Leviticus XXV.)

Walter Jones draws attention to the heavy burdens laid on town and city ratepayers by unrestricted long-term borrowing and urges that the annual redemption of principal should in no case be less than the annual charge for interest.

The present writer finds satisfaction in the recollection that he was able to induce the Finance Department of the Manchester Corporation to set aside large sums *in advance* for the prospective renewal of the sewage filter beds, though a modification of the financial bye-laws was necessitated. By this means interest charges were avoided and the operation had only to be paid for *once*. It may be argued that this was a recurring operation and was not, properly speaking, a capital expenditure. There would seem to be no reason why so-called capital expenditure should not always be paid in advance in this way and thus the perpetual and eternal burden of debt be avoided. The fact that among certain religious bodies a

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* Incidentally it may be mentioned that the present writer became acquainted with the late Mr. Walter Jones in the early days of the Activated Sludge process, and it was the engineering ability of Mr. Jones and his staff of the firm of Messrs. Jones & Attwood, which made the process a practical success. The presentation copy of Mr. Jones' book "Capital and Labour" helped to re-awaken in the mind of the present writer old enthusiasms due to youthful studies of Herbert Spencer, Ruskin, Henry George and others.

church or building used for religious purposes, is not allowed to be dedicated until free from debt, shows again that the religious instinct is against the claims of usury. Cases might be mentioned where even building operations were stopped rather than allowed to proceed in the absence of funds actually in hand.

For 100 years the island of Guernsey has issued its own special notes which are legal tender in the community. For projects such as a harbour and marketplace, contractors were paid in these notes, which were afterwards redeemed by the earnings of the projects in question. Here the community borrowed from itself, there was no question of interest, and consequently no permanent debt.

This brings us to the famous case of Wörgl in the Austrian Tyrol where not only was no interest allowed on the money required for public purposes, but if hoarded it *lost* interest month by month.

In Wörgl the "Natural Economic Order" of Silvio Gesell found its application. Gesell pointed out that while gold was practically indestructible the goods purchased by gold suffered deterioration in course of time. Thus "money" value expressed in gold did not keep step with the real value of commodities. Let money depreciate *pari passu* with commodities and there would be no inducement to hoard rather than to spend. Thus would result what is practically "free money".

Wörgl suffered from stagnation and unemployment. The Burgomaster, a disciple of Gesell, decided to transform Austrian money into Gesellian money. Starting with thirty-two thousand schellings of ordinary Austrian money deposited in a savings bank, bonds of 1, 5 and 10 schellings were put in circulation called "Labour Bonds". They lost 1 per cent. of their value every month unless paid into the Municipal Treasury or into the savings bank. This *negative* interest forced the money to circulate freely; hoarding was discouraged but saving was not prevented since the money which returned to the savings bank remained intact. The little town became wonderfully prosperous, taxes were paid in advance, good roads and buildings were provided and everyone was happy and content until the movement spread to other towns and the bankers became alarmed at this encroachment on their prerogative of issuing money, and brought an action against the Municipality. The present state of things in this and other Austrian towns is unknown to the writer. It would seem possible that the savage persecution of the Socialists in Austria prior to the murder of Dollfuss is not unrelated to this successful application of the theories of Silvio Gesell and the consequent panic among the bankers.

The same idea of negative interest enters into the plan of Dr. Townsend in the U.S.A. who proposes that everyone over the age of sixty shall receive a pension of 200 dollars per mensem on the condition that this amount is *spent* every month and not hoarded.

It is stated by the *Christian Science Monitor* that during his examination before the Ways and Means Committee of Congress, "he brought a laugh when he said 'I am not an economist myself, for which millions of Americans have given thanks'. But he went on himself, unsmiling."

The secret of his plan is again the enormous increase of consuming power effected by the more rapid circulation of stored energy; the kinetic as against the static conception of things.

*Rent* is akin to interest. Anyone who builds a house is entitled to the equivalent of the expenditure of energy employed upon it, *plus* any further work concerned with its maintenance. If the tenant does the repairs the rent will naturally be less. When the tenant has paid the value of the house in rent instalments the house should become his property. In the meanwhile the owner retains the house as security for a loan if he needs it, up to the unpaid value of the house. This is the reverse of borrowing money on an increasingly valuable security such as an insurance surrender value.

*Land* as Henry George so clearly saw is in a different category from buildings. Land like air and water and sunshine is a common heritage of mankind. It is what he termed a "factor of production". To hold land in expectation of its increasing value through the expenditure of energy by others is plainly exploitation. The extent to which the public has been robbed in this way in the early days of railways and of growing cities make the exploits of Robin Hood and highwaymen of later date seem like nursery games. Gangsterdom is no new phenomenon in the United States. The land speculator takes toll of every drop of water in the reservoir of wealth, through owning the land on which, as it were, the outlet sluices are placed.

It is these things which caused Mussolini to exclaim: "I am for those who seek to make technique perfect in order to dominate elements and give to men more sure footing for the future. I do not respect I even hate those men that leech a tenth of the riches produced by others."

Some excuse may be admitted for the rather violent tone of the last sentence, since he is there concerned with the real enemies of his country. It is a pity that on the other hand he should by his militaristic propaganda influence little children to regard as enemies those who, in a better world, would only wish to be their friends.

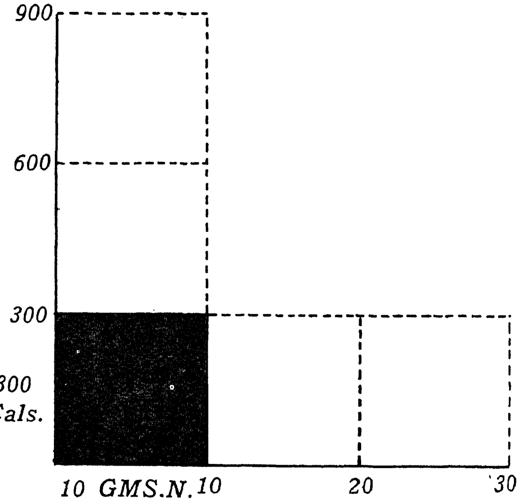
Among the 25 points of the National Socialist German Workers Party are the following as given in Hitler's autobiography, "Abolition of income unearned by work. No speculation in land. Death penalty for usurers and profiteers."

From the Williamsburg Bridge in Greater New York can be seen the whole skyline of Manhattan. Every day it is different they say, as new buildings rise and the old are pulled down. Gazing on this scene of pulsating life, the "Fire Magic" of "Die Valkyrie" echoes in memory. The land-speculator is no Siegfried that he should control these leaping flames of energy.

CURRENCY.

The subject of currency as viewed under the Energy concept has already been dealt with tentatively in an article by the present writer entitled "Chemistry and Currency" published in *Current Science*, Vol. I, No. 2, 1932. An accountancy unit was suggested called the ERN, being the daily *Nitrogen* ration of an adult human being together with its equivalent energy. This nitrogen ration, consumed as protein in various forms, such as meat, fish, milk, curd, peas or beans, may be taken without serious error as 10 grams and the corresponding energy liberated as it passes through the human system as 300 calories. This suggestion was first published in *Capital* on March 3rd, 1932, quite without knowledge of similar trends of thought in the writings of Professor Soddy of Oxford, of H. G. Wells and of Sir Daniel Hamilton, whom the writer had the pleasure of meeting shortly afterwards. An attempt to bring the idea before the Rotary Club of Calcutta met with little response, in fact with some amount of ridicule. Nevertheless it was subsequently learned as already mentioned, that the basic idea had been in operation for 25 years at the Victoria Falls and Transvaal Power Company, and that the Technocrats in the United States proposed to base their accountancy unit on the kilowatt hour. Actually every engineering concern works out its costs largely on Man-hour consumption.

Subsequently, in the discussion in the *Charka*, the organ of Calcutta Rotary, the following diagram of the ERN was published and it may serve to make clear the basic idea of this unit of currency.




The ERN is really a unit of *Wealth* since it represents the two fundamental *factors of production* to use the term employed by Henry George. He considered land, labour and capital as the three factors of production, but later spoke of them as two, *viz.*, natural substances and human exertion—which two factors by their union produce all wealth. We have seen that the more modern conception of the two factors of production would be food (or Nitrogen the most constant element in food) and energy. Thus according to the foregoing diagram, the calories, or equivalent energy units, produced by a high-powered machine, operated by one man, would extend vertically to an indefinite height. No one could argue that the one man himself *produced* all that energy or that he could lay claim to its resultant "goods" on that account. Still less, however, could there be a claim to such energy simply on account of certain payment in *money* by individuals who have no other claim to its possession. The origin of the machine indeed lies deep in the past of the race and is the outcome of the work and inventive

thought of countless minds. There can be no inherent possessive right to the machine any more than to the enhanced ground rents in Manhattan created out of the labour and thought of the myriad sojourners on that island.

On the other hand if the Nitrogen side of the ERN diagram is extended we have a representation of the value of the crop sown or cultivated by one man but grown with the assistance of sun and air.

Further we have the vast reservoir of Nitrogen, contained in human, animal and vegetable nitrogenous waste material, or recoverable from the atmosphere by the activities of the nitrogen fixing bacteria.

In an article entitled "Scavengers All" in the *Harijan* for March 15th, 1935, Mahatma Gandhi quotes with approval the data collected by the present writer, according to which the human excreta at present worse than wasted in India, represent if wisely used an annual gain of 60 crores of rupees to the country.

We find indeed that all real wealth is in fact the natural inheritance of all who will work in co-operation with the forces of nature and their fellowmen to produce it. Money is *not* wealth, it is only a claim to wealth through the performance of labour.

It may here again be emphasised that payment in ERNS does not mean equal payment for all, nor that the *value* of any piece of work depends on the physical energy expended in its execution.

The ERN is a measure of *wealth* in the sense that an inch is a measure of *length* or a pint a measure of *capacity*.

Payment in ERNS means, however, that the reward of labour whatever it may be, is not dependent on the scarcity of a metal, or the whim of a banker.

As stated earlier the idea of an energy unit as a basis of accountancy is not new and will almost certainly in some form be adopted in the new world to which many are looking forward. The advantage of the ERN lies in the combination of the two factors, food and energy, so that it can serve as a measure both of the mechanical and agricultural wealth of a country. Thus in the Cauvery Falls the Mysore Government has an unfailing source of energy units, every 300 calories of which is equal to one ERN: in its fields is produced so much protein Nitrogen, every 10 grams of which is equal to one ERN.

It cannot be sufficiently emphasized that the coming of the telegraph, the aeroplane and the radio, and now on the horizon, television, has caused the world to close up its boundaries to an indefinite extent; it is easier to communicate between Bombay and London than it was between London and Edinburgh less than a hundred years ago. All the vast tangle of national currencies as well as weights and measures must inevitably disappear with the growth of intelligence. Even before this ancient clutter is discarded some form of international currency will become imperative. The writer was impressed, *e.g.*, with the fact that in travelling from Madras to Shanghai without at any point leaving British territory, it was necessary to change his money about half a dozen times. A certain type of individual in Shanghai manages to maintain existence by buying and selling currency according to the reports of the tape machines.

In this connection the effect of climate on industrial development should not be forgotten. It is very strikingly shown on a map given on page 125 of Lord Melchett's *Modern Money*. A quaint philosopher's one reply to all suggestions for reform in India was: "You must alter the path of the Sun." No one would deny that much can be done to modify the effects of climate, but as a general proposition, climatic differences are likely to control the economic situation for a considerable time to come and therefore an international currency which is equally useful both in an industrially developed country and among a more agricultural population, has manifest advantages.

A word may be said here with regard to an objection which has occasionally been voiced, namely, that with the issue of ERN notes it would be difficult to avoid inflation. On the contrary, the issue of notes of this kind would probably be always far behind their potential backing in real wealth, since though it is not easy to make a complete assessment of a country's potential wealth, it can be arranged without difficulty that the ERN issue shall not exceed a certain proportion of the ascertainable assessment.

The mere indiscriminate printing of so-called money as was done in Germany is now realised to have been an act of lunacy which is not likely to be repeated.

### Possibilities of Change.

It is now to consider how far the state of consciousness of the world is ready to accept the ideas set out in the foregoing thesis and in the many similar writings on which it is based.

The main hindrance to acceptance of such views is the need, which becomes apparent at once on a study of the situation, for the elimination of the *Profit Motive* in industry. No less an authority than Sir Josiah Stamp states that the "mainspring of all individual enterprises is the getting of profits." There are very serious grounds for disagreeing with him. To begin with the whole of Soviet Russia carries on without the profit motive as commonly understood; emulation, yes; increased remuneration for good work done, yes, but that is nothing more than occurs in every reputable Civil Service whose members would be indignant if accused of working simply for money.

The whole training of youth in Russia is against the very idea of profit making. A young Russian lad was asked, 'If a man buys 6 dozen apples at 18 kopeks a dozen and sells them at 36 kopeks a dozen what does he get?' The boy's answer was "A jail sentence."

The rise of the Rotary Club movement with its motto "Service before Self" is certainly significant. Many of the greatest business or even capitalist leaders such as Henry Ford can rightly accept this motto since their object is not *personal* possession but service to the community.

Rumour stated that the personal expenses of Cecil Rhodes did not exceed £600 a year.

It is the evil lust of *personal possession* that is the enemy which has to be fought. M. P. Willcocks writes:—

> "The passion to possess, though it is judged now by many to be the very tap-root of misery and wrong, has only recently come into the zone of conscious thought because its worldwide sway as a motive has only recently been recognized."

Soames Forsyte in fiction and Pierpont Morgan in real life are typical examples of the "possessive" complex. Both had a fine taste in art and also for the market value of the objects of their desire. With Soames Forsyte his claim to possession extended to the person of his wife. Pierpont Morgan is reported to have said, "I can buy any 'scientific' man for 500 dollars and make half a million out of what he tells me." Already, however, the number of Soames Forsytes in the world is rapidly decreasing, and the reputation of Wall Street has recently been sadly blown upon.

To use the word employed by Professor Miles Walker, a *eudæmonistic* spirit is now widely manifested. Professor Miles Walker states that this eudæmonistic quality is very often found in engineers and scientists:—

> "A man has this quality when he throws the whole of his energies into the carrying out of sound. practical and beneficent projects for the sake of those projects themselves and not primarily from selfish motives or in pursuance of some irrational prejudice."

The chief desire of such men is to *live* and not to be continuously pre-occupied with the means of living. With more and more of these men in the world, the selfish quarrels of politicians and fomentors of racial antipathies, with all such wastes of human energy, will disappear like the clamour of a bad dream which has overpassed. In the meanwhile what practical steps can properly be taken?

### STEPS TOWARDS RECONSTRUCTION.

In the first place without doubt a determined effort must be made to lift the burden of *interest*, the grasp of the dead hand, from the coming generations.

That such a step is possible, even in a conservative eastern country, is shown by the case of Siam where the philosophy of the gentle Gautama forbade violence but also insisted upon justice. In consequence the Government stepped in and passed a law enabling the farmers of every village community to form themselves into a Co-operative Society that would adopt and become collectively responsible for the debts of each individual member. Any society, once formed, could approach a bank (guaranteed by the King) for a loan sufficient to pay off all the money-lenders operating in that district. The Society has to pay 6 per cent. interest for this accommodation to the bank; and it is allowed to charge 12 per cent. to its members. It may thus amass in course of time a balance for the liquidation of its indebtedness to the bank and to provide capital for the acquisition of modern agricultural implements. It is calculated that after a period of not more than 25 years the rice cultivators of Siam will not owe a tical to the foreign usurers and then it will be possible without offending Buddha to banish every money-lender from the country.

The reduction of interest on British or British Indian Government Loans is already rapidly taking place as can be verified in the experience of the majority of people. That this presses hardly on the "rentier" cannot be denied, but in time such a class will diminish, possibly even in France. It must

be remembered that with reduction of interest there must go also a reduction in Income-Tax so that the net effect is not so serious as it might appear.

In the coming time moreover there will exist far fewer "old" people who are merely spending their time. Increase of *life* will mean increase of wealth sufficient to support such people in a happy bright existence very different from what is now often their lot.

It should no longer be possible to plead lack of money for not proceeding with "nation building" activities; where men and materials exist, there is also wealth.

Already Sir Montague Webb has put aside for the time his strenuous advocacy of an increase in silver currency and at a public meeting in Karachi, presided over by the Mayor, proposes the issue of "Service Notes" which would circulate like ordinary currency, to raise funds for a water supply scheme for Karachi estimated to cost Rs. 1,50,00,000. Sir Montague quoted the case of the Guernsey market mentioned earlier in the present paper. He very properly stresses the point that his scheme would have to be pushed with great persistence and determination as it would be opposed from all sides, more particularly by the money-lending classes.

There have been many suggestions for experimental colonies to try out some of the ideas adumbrated in the foregoing pages.

In Burnaby, British Columbia, the "Army of the Common Good" has set about organizing a life where production shall be for use and money shall be a system only of Labour Notes sufficient to exchange mutual services.

Captain Petavel in India has for long advocated Educational Colonies where youth should earn while learning.

Lt.-Col. H. Jarrett-Kerr as Representative of the Rural Reconstruction League of India writes of a Co-operative Commonwealth where there would be no hoarding or cornering the medium of exchange and where there would be equal distribution of commodities and services.

Professor Miles Walker writes to a member of the staff of the Indian Institute of Science urging an experiment to be carried out by volunteers, the main thing differentiating the experimenters from the rest of the people being their type of money designed to bring about a free circulation of all commodities manufactured by the community. "This community would trade as a whole with the outside world, just as India now trades with a foreign country for things they cannot produce themselves."

Some months ago a sketch of such a project was submitted to the present writer according to which a number of young educated Indians were to start some kind of Industrial Colony on their own, which would begin by borrowing capital at 5 per cent. interest. It was pointed out that such a suggestion must necessarily wreck the scheme at the outset, since there were very few industries which could pay a steady 5 per cent. in addition to necessary expenses of labour and material, when averaged over the period of inception and full running, and that the only result would be that the young pioneers would begin their existence as slaves to the money-lender. It was pointed out that they *themselves* were Capital with their combined ability and education. It was impressed upon them further that all living things grow from seed and that without this element of life amongst them, nothing could ultimately develop, with it all things were possible. The case of Henry Ford himself who started as a motor mechanic was quoted, and the history cited of his famous encounter with the bankers who in time of crisis came as friendly spiders offering the shelter of their "parlour" to him, the innocent fly.

The only sound method for beginning an industrial colony of this sort must be for the members each to contribute what little they have, like the citizens of Wörgl, and then to circulate that deposit in the form of "Work Tokens" for the energy which would find its first outlet, may be, in tilling the ground or building a shack, out of which one day would emerge the industrial village, or even the industrial city. Their real capital would be their knowledge, their physical energy and their character.

Sir Daniel Hamilton has successfully launched a Co-operative Colony on his Gosaba estate in the Sunderbans, Bengal.

His scheme includes the following proposals:—

1. That the Government of India lends say Rs. 1,50,000 for the establishment of a Bolpur-Gosaba Training Institute for co-operative workers.

2. That the Government of Bengal place at his disposal a block of land in the Sunderbans for the purpose of creating an estate of say 10,000 acres, to be worked on co-operative lines, which estate will remain the property of the Government of Bengal.

3. That the Government of India lends the money required for the development of the estate, say about Rs. 2,00,000.

He states that the question of financial stringency does not arise as the finance required for the schemes thus outlined does not cost either the Government of India or the Government of Bengal anything, the credit required is found not by borrowing or by taxation, but by monetizing the brain-power of the Bhadralok and the hand power of the people.

Sir Daniel bases his policy on the practice which obtained in the old days in Scotland when banks issued their own notes and used them to finance young men of known antecedents and good character. It was in this way that the foundation was laid of the agricultural prosperity of Scotland.

It may be remarked that all these schemes have some analogy with the Co-operative Wholesale Society whose operations are now on a very large scale. It may be doubted, however, whether the questions of money and interest have been fully thought out by the members of this Society. In the community envisaged by those who are controlled by the concept of Energy, every worker at the end or his daily task will simply require to have his worksheet signed by some responsible individual when he would go to an office either of the special community, or, later on, to the State, when the idea becomes universalized, and obtain the proper equivalent in ERNS to be exchanged for goods in payment for his completed task. It may be anticipated that these ERNS, if unspent, will only maintain their value like the Wörgl "Work Bonds" for a definite period, after which they will lose interest steadily, unless put into the State or Community Savings Bank, where they will not earn interest but will remain available for spending at some other time.

Professor Miles Walker rightly states that the method of the scientific man or the engineer is to make trial by experiment of the new ideas which have come to him in the course of his thinking. The trouble about many of these experiments in the past has been that the governing conditions of success have not been fully understood or sufficiently explored. With all the resources of modern science and the freedom of modern thought these hindrances to success should be recognized and dealt with at the outset. Freedom of thought is perhaps the most essential need before any useful social experimentation can be put in hand. It is strange how few are really free. The man of science, knowing that twice 2 remains 4, not only sometimes but all the time, should be unaffected by the taunt of adherence to any "ism", political or economic. He is merely concerned with the truth of things, which, in the end, must make men free. In the atmosphere of true scientific thought there can be no room for prejudices or selfish fears, nor, it may be added, for selfish ambitions.

It is important to remember that in the modern world changes of thought come about with accelerated velocity.

Throughout the whole period of recorded history, prior to about a hundred years ago, the speed of locomotion did not exceed the speed of a horse. Then came the locomotive.

It is a mere thirty years since the first aeroplane made its "faltering flight" over the Dayton sands.

These changes manifestly express a corresponding liberation of thought in regard to the problem of locomotion.

Is there not hope therefore that similar progress may be manifested in the attitude of mind with which humanity faces the problems of war and poverty?

The perils of "mass suggestion", and the many means for producing it, are becoming widely recognized as a cause for grave concern.

Why should not the same or greater energy be employed to disseminate right and true ideas? Let us hope that the projected development of Broadcasting in India will be used to spread wisdom as well as knowledge.

The deep importance to the present world of a fundamental change in viewpoint is sufficiently evident, and the foregoing exposition may fittingly conclude by quoting the last paragraph of Silvio Gesell's Treatise on "The Natural Economic Order."

"Everyone would of course like to enjoy the blessings of civil and international peace, and at the same time live on capital-interest. But those who have discovered that the possibility of doing so is a Utopian fantasy, an illusion of naive minds: those who recognize that war and interest are inseparable, must choose one or other of these alternatives: either interest and war, or earned income and peace. Such persons, if really animated by peaceful Christian feelings, will accept with rejoicing the latter alternative; such persons have the right inner preparation for understanding "The Natural Economic Order"; it is for them that the book has been written, and it is they also who, undeterred by opposition, will carry through the reforms it proposes."

SUMMARY.

The vast possibilities of the utilization through modern scientific discovery of the unlimited resources of solar energy are illustrated by examples. Attention is drawn to the fact that energy units have already been used in practice as a *Measure* of value.

The terms *value* and *profit* are distinguished and reference is made to the difference of viewpoint exemplified by the civilization of the Incas and that of their Spanish conquerors.

An analogy is suggested between the conception of heat as *caloric* and of gold as *wealth*. In the modern world the concept of *energy* should control true economic thought, rather than any one material substance such as gold.

It is shown that in the world of plenty foreshadowed by the achievements of physical science, production for *profit* is ultimately impossible, except by exploitation or war.

Attention is called to the importance of thinkers trained in the methods of modern science devoting consideration to the problems of present day economics, if disaster is to be avoided.

The consequences of the concept of energy are considered in relation to *Capital*, *Interest*, *Rent*, *Land* and *Currency*.

The suggested unit of *Man-Power*, known as the ERN (*viz.*, the daily Nitrogen ration of a man, with its corresponding energy value), is explained, and its advantages as a universal currency medium discussed.

The question as to how far the thought of the modern world is ready for the new kinetic viewpoint is considered and several encouraging signs are noted.

Finally reference is made to recent efforts, embodying some of the ideas set out in the article, and the need is again urged for the co-operation of thoughtful people in the building of a new world.

## *References.*

The following sources of information were consulted in the preparation of the foregoing paper:—

BOOKS.

Adams, W., *Real Wealth and Financial Poverty.*
Angell, Norman, *The Peace Treaty and the Economic Chaos of Europe; The Money Game; The Unseen Assassins.*
Arkwright, Frank, *The A.B.C. of Technocracy.*
Bagehot, Walter, *Physics and Politics.*
Baldwin, Oliver, *Unborn Son.*
Bellamy, E., *Looking Backwards.*
Blackett, Sir Basil, *Planned Money.*
Brayne, F. L., *Socrates in an Indian Village; Village Uplift in India.*
Brown, William, *The Inherent Function of Money.*
Cole, G. H. D., *The Intelligent Man's Guide through World Chaos.*
Crookes, Sir William, *The Wheat Problem.*
Darling, J. E., C.B.E., *The "Rex"—A New Money to Unify the Empire.*
Douglas, C. H., *Social Credit.*
Field, A. N., *The Truth about the Slump.*
Forbes, Rosita, *Eight Republics in Search of a Future.*
Ford, Henry, *My Life and Work.*
Fowler, Gilbert, J., *Introduction to the Biochemistry of Nitrogen Conservation.*
George, Henry, *Progress and Poverty.*
George, Lloyd, *The Truth about Reparations and War Debts.*
Gesell, Silvio, *The Natural Economic Order.*
Gibbs, Sir Philip, *European Journey.*
Hawtrey, R. G., *The Gold Standard, Theory and Practice.*
Henderson, Fred, *The Economic Consequences of Power Production; Foundation of the World's New Age of Plenty.*
Hitler, A., *My Struggle ("Mein Kampf").*
Hodgson, John, *The Great God Waste.*
Hurst, *Mechanism of Creative Evolution.*
Huxley, Julian, *A Scientist among the Soviets; Scientific Research and Social Needs.*
Jameson, Storm, *No Time like the Present; The Decline of Merrie England.*
Jones, Walter, *Capital and Labour.*
Lawrence, Pethick, *The Money Muddle and the Way Out.*
Martin, Kingsley, *Low's Russian Sketchbook.*
Marx, Karl, *Capital.*
Maxwell, D. W., *The Principal Cause of Unemployment.*
Melchett, Lord, *Modern Money.*
Meulen, Henry, *Industrial Justice through Banking Reform.*
Mussolini, Benito, *Biography.*
Newsholme and Kingsbury, *Red Medicine.*
Nichols, Beverley, *Cry Havoc.*
Pratt, Ambrose, *Magical Malaya.*
Priestley, J. B., *English Journey; Wonder Hero.*
Prescott, *Conquest of Peru.*
Robertson, D. H., *Banking Policy and the Price Level.*
Roosevelt, F. D., *Looking Forward.*
Ruskin, *Unto This Last.*
Salter, Sir Arthur, *Recovery.*
Scott, Howard, *Introduction to Technocracy.*
Shaw, G. Bernard, *The Political Madhouse in America and nearer Home.*
Simonds, Frank H., *America Must Cancel.*
Smith, Adam, *Wealth of Nations.*
Soddy, Professor, *Money* versus *Man; Wealth, Virtual Wealth and Debt.*
Thwaites, Lt.-Col. Norman, *Velvet and Vinegar.*
Wells, H. G., *The Work, Wealth and Happiness of Mankind; The Shape of Things to Come.*
Willcocks, M. P., *Between the Old World and the New.*
Wingfield Stratford, Esmé, *The Victorian Aftermath.*

ADDRESSES, SPECIAL ARTICLES, PAMPHLETS, AND REPORTS.

Eddington, Sir Arthur, *Lecture Recorder*, December, 1932.
Ewing, Sir Alfred, "Power", Address to the Engineering Section, British Association,

Fowler, Gilbert J., "The 'Ern', a New Medium of Exchange," *Capital*, 3rd March, 1932; "Chemistry and Currency," *Current Science*, Vol. I., No. 2, August, 1932.
Hamilton, Sir Daniel, *The Man Standard; The Co-operative State and How to Reach It; The New Constitution and the Bread Problem; Rural Reconstruction; The India White Paper and the Co-operative Government.*
Hodgson, John L., "Some Aspects of the Problem of Industrial and Communal Waste, with Discussion," *Journal of the Royal Society of Arts*, February 19th, 1932.
Hopkins, Sir Frederick Gowland, "Some Chemical Aspects of Life," Presidential Address to the British Association, 1933.
Jarrett-Kerr, Lt.-Col. H., "Year of Jubile" Rural Reconstruction League of India.
Jarvis, J. Gibson, "Instalment Buying," *Journal of the Society of Arts*, April, 1932.
Jones, Gavin, R.T.C., "Note on the Economic Situation for the consideration of the Upper India Chamber of Commerce."
Keeble, Sir Frederick, "The Green Plant as Agricultural Engineer," Hawkesley Lecture, Institution of Mechanical Engineers.
Kitson, Arthur, "Letter to H.R.H. the Prince of Wales on 'The World Crisis, Its Cause and Remedy.'"
Leverhulme, Viscount, Presidential Address to the London Chamber of Commerce.
Petavel, Captain, Numerous pamphlets on Educational Colonies.
Walker, Professor Miles, "A Call to the Engineer and the Scientist," Presidential Address to the Engineering Section, British Association, 1932.
The Rural Report of the Liberal Land Committee, 1923–25.
The Protocols of the Learned Elders of Zion.
Publications by the Industrial Christian Fellowship.
Interim Report to the Church Assembly of the Social and Industrial Commission on Unemployment.
"Monetary Reconstruction," Monetary Reform Association.
*Times Supplement* on Gold, June 20th, 1933.
"The Case against Gold," *The Times*, April 9th, 1934.

GENERAL.

The subject has been followed in the newspaper and magazine press: particularly in the *Christian Science Monitor*, the *Statesman*, the *Chamber of Commerce Journal* and the *Lecture Recorder*.

Numerous articles by competent writers occur in such popular publications as *Nash's Magazine*, and *Passing Show*, indicating the wide appeal of the subject.

In the *Planters' Journal*, 1932–33, a correspondence between Sir Montague Webb and the present writer was followed by a valuable series of articles by Major B. J. Temple.

Mention may be made of the weekly paper, *Life*, published in Bangalore and edited by E. Kirk, which has devoted its first attention to the discussion of modern problems in Economics.

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## Trade and Industry.

SINCE the above was written, we have come across an account of the proceedings of the fiftieth anniversary of the School of Incorporated Accountants and Auditors, London (*The Chamber of Commerce Journal*, May 1935, page 360). In the course of his reply to the toast by "Trade and Industry" proposed by Sir Josiah Stamp, Sir Stephen Demetriadi, President of the London Chamber of Commerce, quoted the old rhyme:—

"The centipede was happy quite,
Until the toad in fun
Asked him which leg went after which
Which worked his mind to such a pitch
He lay distracted in a ditch
Considering how to run."

and said, "We had succeeded in making what was comparatively simple business, so complex that trade and industry, like the centipede, were lying down and passing quietly away. In simpler and saner days, it was clearly understood that the reason why a man produced was that he, his friends, relatives and retainers might consume, and these simple souls would have been amazed to learn from us that what they should have done to become truly wealthy was to have restricted the production, burned or otherwise destroyed some of it, and in this way, by making it scarcer, made it more valuable....... It sometimes seemed that the present impasse was so essentially devoid of reason that perhaps the answer hidden for the wise and prudent, might yet be revealed to babes and sucklings. The centipede might forget all about the toad and just get up and walk quietly away."

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CONTENTS.



## Presidential Address.

By J. H. Hutton, C.I.E., M.A., D.Sc., F.A.S.B., I.C.S.

[The preliminary portion of the address is devoted to a recital of the history of the Academy movement which led to the formation of the Committee by the Indian Science Congress and the subsequent developments, ending in an exhortation to the Congress members to accept the report of the Committee for the formation of the National Institute of Sciences of India. Dr. Hutton then proceeds to give an account of the social and anthropological problems arising from the Census Report of India for 1931.]

I NEVER realised, nor came near to realisation of the vast field that there is in India for the organised efforts of science until the Census of 1931 put me into a position in which I could hardly overlook it. The first essentials of sociology are accurate statistics, and most of the few statistics available in India are obtained by crude methods and give results which are insufficiently exact. We know for instance that the population has increased but we can only guess at the causes; we cannot in India as a whole be certain of where or when the increase took place beyond locating it over a period of 10 years. In Madras alone was the registration of births and deaths sufficiently accurate for the population of 1931 to be determined approximately before the counting took place, and even then we cannot be sure that that accuracy was not an accident. How far the variation of fecundity in different parts of India is due to environment, heredity or social customs we have no means of knowing, since detailed local studies are wanting. Mr. Porter in Bengal has embodied in his Census Report for that province an interesting speculation on the future growth of the population of Bengal; but the figures on which it is based being limited to seven enumerations are not enough to warrant our taking it as more than a speculation. Even so it leads us at once to the urgent need of a greater application of science to matters of rural economy. It is probably true enough that improved methods of agriculture can so increase production that the population of this country is not an immediate danger of outstripping its potential food supply. But I say potential advisedly. It is very clear that in other respects the position is serious. The vast majority of India's population live an agricultural life

not only by force of circumstances but by deliberate preference and under their existing conditions of ignorance and of absence of capital, the population attempting to live by agriculture is likely to become, if it has not already done so, much too numerous for the land to support. The subdivision of holdings which are insufficient to maintain their owners, must tend to reduce the economic output from their land while the increase of cultivators and in particular of landless agricultural labourers calls for an increasingly high return from the land. In limited areas and to a limited extent some relief is afforded by seasonal industries (such as cotton in Central India) which enable the agricultural population to add to the income derived from land; in other areas cottage industries give similar assistance, but the extent of these reliefs is entirely inadequate to the need, and there is an obvious call for a great extension of part-time industries in which the cultivator can find employment when he is not required on his fields. To give one instance, it is probable, if not certain, that the application of scientific methods of breeding, feeding and selection could double the outturn of silk in India without any increase in the number of cocoons, and could at the same time enormously improve the quality of the silk. Indeed, for at least one Assam tribe the silkworm provides not only clothing but an article of food, as the pupa is much relished and reserved as a delicacy for favoured guests. But without seeking to popularise this use of the silkworm, the extension of silk producing, on scientifically improved methods, as a cottage industry might make India easily the premier silk-producing country in the world.

Further, although at present there may actually be enough food in quantity to prevent the great majority of cultivators from going hungry, it is becoming increasingly apparent that their diet is very often extremely badly arranged. A very great deal of the disease in India is deficiency disease due more to a badly chosen diet than to actual scarcity of foodstuffs. This point is well brought out, for instance, in Mr. Yeatts' Census Report on Madras where he emphasises the researches of Sir R. McCarrison on the causes of blindness in India indicating that the widespread prevalence of keratomalachia is due to a diet deficient in fat-soluble vitamins. It is likely also that leprosy, to take another instance, is encouraged by deficiency diets. Sir John Megaw again, in his paper on *Population and Health in India*, tells us that in India, although three meals daily is more common than two, 'malnutrition due to unsuitable diet is the rule rather than the exception'. Here then is one practical task for doctors and health officers: that of prescribing a suitable diet within the means of the very poor conformable to the local products available in the neighbourhood. An example of what can be done in this way may be seen in Mr. Mukerjea's Report on the Census of Baroda, 1931, where Dr. F. P. Antia and Mr. F. S. Kale give a food survey of the principal castes in the State. I would at this point put in a word of warning against those enthusiasts for reform and improvement whose zeal is greater than their knowledge. It is perhaps partly because the results of intemperance are so obvious and easily appreciated that the advocates of temperance are apt to be fanatic extremists, though I have known some who tempted one at times to recall Samuel Butler's caustic comment on the Puritans who 'compound for sins they are inclined to by damning those they have no mind to'. My point is that home brewed beers form a very important element in the diet of the more primitive tribes and castes of this country. Not only does the very moderate amount of alcohol in these brews supply for certain purposes the want of sugar which in many of their environments they cannot obtain, but the recent researches of Col. Chopra on vitamins have shown that the home brewed beers of India contain many very valuable vitamins, and there is consequently a serious danger that propaganda or legislation directed to the suppression of the use of these liquids may result in the spread of deficiency diseases, and add one more tally to the lamentable tale of damage done by well-meaning but ill-informed tampering with customs that are disapproved by the reformer but are in fact useful adaptations to environment on the part of the ones to be reformed.

Unfortunately, however, it is not only rural economy which calls for the aid of the scientists, though the rural call is the more urgent, not only because there are more than eight countrymen for every single townsman in India, but because the rural population is infinitely the more conservative and therefore in much greater need of that 'new outlook on life', the necessity of

which is admirably emphasised by Sir John Megaw, in the paper which I have already cited, with a telling quotation from the concluding chapter of the Report of the Royal Commission on Agriculture. Such a new outlook is easier for the townsman to acquire, for in exchanging a rural for an urban life he comes into daily contact with new ideas and new ways of living. Unfortunately, these ways of living are in some respects no improvement on the old. The Indian village, at any rate in northern, western, central and parts of southern India, often on a constricted site which cannot be expanded on account of the need of land for agriculture, is apt to be congested to a highly insanitary degree: but in towns this condition is often incredibly accentuated, and while 26% of Bombay's 1,161,380 inhabitants live under conditions of the grossest overcrowding, 74% of that population live in one-roomed tenements at more than 4 persons per room. Buildings of one storey predominate in Indian towns, which makes the figures of congestion, when the population for a given area is compared with congested population in Great Britain, appear lower than they really are, but where, as in Cawnpore, tenement buildings are used, the congestion is almost incredible. One chak of the Anwarganj ward of Cawnpore contains a density of 786,560 persons to the square mile, a figure untouched by the worst of the metropolitan boroughs of London. Obviously there is a need for scientific planning in the outlay and growth of all developing urban areas if a repetition of this sort of scandal is to be avoided. It was a matter of considerable surprise to me to find that in many parts of India the existence of a town with a large and concentrated population was regarded as an occasion for pride and complacency. A large town appears much rather to me as a source of fear and repulsion. It is true that the works of such men as Sir Raymond Unwin have shown that there is no need for this, but nevertheless such parts of India as Assam, Malabar and Eastern Bengal, where any close concentration of population is the exception, appear to be the more fortunate for that, and India has a wonderful opportunity of profiting by the experience of Britain and avoiding, by careful and scientific planning while her industries are still in their infancy, any further concentration of industrial population in congested areas.

I have referred to these points of rural economy of diet and of town planning merely as instances of matters in which science may and should be utilised and directed for the benefit of the community; there must be many more which will no doubt be discussed by the various sections of this Congress, much more fruitfully than by me. There are, however, certain aspects of my own special subject to which I propose now to direct your attention. India offers a vast field to anthropologists and opportunities such as exist nowhere else in the world, forming as she does a veritable museum of living physical types, of social organisations, cultures and religious beliefs. From the point of view of physical anthropology there is a vast amount of work to be done. India contains in forms that are anatomically distinguishable elements derived direct from the negrito races which constitute probably the oldest type of human being anywhere surviving. These elements are no doubt few and rare, limited to the Andamanese, rapidly alas becoming extinct, and to one or two of the remoter jungle tribes of the south of India. Similarly there are to be found survivals of that other eastern negroid race, the Melanesian. These survivals are more easily to be traced in culture than in anatomy, and it is not unlikely that the typical appearance of the Melanesian race itself is the result of hybridisation. Nevertheless evidence is to be found of affinity in physique between some of the Assam hill tribes and the races of Papua and New Guinea, and it is probable that such affinities occur again in some other parts of India. On the other hand, the physical type which Col. Sewell has conveniently labelled Proto-Australoid is widespread in India and Burma. This race possibly represents an early branch of the brown race of the south-east Mediterranean which migrated eastwards at a very early date and has been modified by environment to produce a markedly different type. On the other hand, it may be connected with some of the recent finds in Palestine, which Sir Arthur Keith appears to regard as related to surviving types of man. These views are not necessarily mutually exclusive. This race is represented most strongly in the lower castes and in some of the aboriginal tribes particularly of southern India. These races have been followed by others whose order of coming is more difficult to determine. One race of invaders, probably

likewise moving from north-west to south-east, must have brought in the Mon and Munda languages and possibly the keeping of sheep. Like their predecessors they seem to have formed definite connections overseas and to have moved on from India to Indonesia as the succeeding races did afterward. It was perhaps after their coming that the Parœean or Mongoloid races began to come down from the north-east, particularly in eastern India and Burma, but whether they ever penetrated far into India except at a much later date is doubtful. There is a suggestion of the Mongoloid about many tribes, in the Madras Agency Tracts, for instance, but it is not clear that this element did not come in from the east by sea together with the returning wave of speakers of Mon languages which certainly came back from the east westwards into Assam. In 1930 Mr. J. P. Mills and myself published in the *Journal of the A.S.B.* an account of some stone funerary urns found in the North Cachar Hills, which were then, as far as we could ascertain, unique. Since that date groups of very similar urns, used for an obviously identical purpose, have been discovered by Mdlle. Colani of the École Française d'Extrême-Orient in Tonkin in Indo-China, so that the Khasi-Synteng group in Assam can now be connected with the Far East culturally as well as linguistically.

And here is a point at which the geologists can help us. I have suggested elsewhere that a wave of immigration into India from east or south was caused by the subsidence of the mass of the Indian Archipelago. There are traditions among the hill tribes of Assam, Burma, Eastern India and the islands themselves which seem to me to point to a great volcanic cataclysm and a submergence of land under the sea which drove them to escape into the hills and ultimately to migrate; Messrs. Peake and Fleure, in that admirable series *The Corridors of Time*, have pointed out that if the coast line of the Indian Archipelago be extended to the hundred fathom line a great land mass appears which very nearly joins the Asiatic continent to Australia, and that some such reconstruction is necessary to account for the early occupation by man of the Australian continent; Molengraaff and Weber in their work on the Zoology of Indonesia have pointed out that the distribution of the species of freshwater fish in the islands suggests land continuity up to a comparatively recent date. The suggestion I made of the migration of certain tribes as the result of a volcanic upheaval and submergence met with quite definite disapproval at the hands of the geographers to whom I propounded it last year in London, but since then I notice that Corbett and Pendlebury in their work on the Butterflies of the Malay Peninsula have been led independently to a precisely similar conclusion to that reached by Molengraaff and Weber when working on the fish; I think I am justified therefore in stirring up the geologists to re-examine the possibility of the subsidence of Indonesia after its occupation by man, and at what is, geologically speaking, a recent date.

Whatever the provenance of the Mongoloid element in India, however, its physical influence appears to have been very small, and the main bulk of India's population would appear to be of Mediterranean origin, and it is possible to show much evidence for a continuity at a very ancient date of both race and culture from south-eastern Europe through Asia Minor, Syria, Mesopotamia and Iran to India. Into this population brachycephalic elements have entered probably coming both in the form of an admixture with the civilised Mediterranean and also in the form of a definite brachycephalic migration which has affected certain areas in India, of which Bengal is one, very much more strongly than others. It is possible that this latter brachycephalic element brought in the Pisacha or Dardic branch of the Aryan language, a purer form of which followed with the dolichocephalic Aryan invasion of about 1500 B.C. This difficult question I have discussed at greater length elsewhere, and I do not pretend to regard the position advanced as conclusively proved and established. What I do urge is that the question of race in India is one which calls for very careful and detailed examination by trained anthropologists on the lines recently adopted by Dr. Guha of the Zoological Survey and those workers who have been assisting him. The method of working by the coefficient of racial likeness is laborious and involves an amount of mathematical calculation which is more laborious even than the taking of the measurements, but results of permanent value cannot be obtained without the initial labour and this should be extended to all parts of India and to every tribe and caste.

It should also be supplemented by a corresponding analysis of the blood groups of such castes, since it is possible, if not probable, that these may give no less important indications of relationship than anthropometrical measurements. You have in India in the caste system a most valuable opening for approach which is denied to other countries where racial mixtures have gone on in a far more promiscuous way than they have in India. I do not suggest of course that caste is any necessary criterion of race. I feel certain that it is not, but it has divided up the population into endogamous groups which must have very greatly retarded and restricted the extent of miscegenation, and investigation is urgently called for before that system begins to break down under modern conditions. Meanwhile that same system affords opportunities for the study of human genetics not found elsewhere; it also opens up an approach to the study of the effects of environment on physique, since if castes which can be shown to have had a common origin and to have kept their strain pure but which are now domiciled in different parts of the peninsula are found to differ physically, the differences may be examined to see how far they can be traced to climatic or to other environmental causes.

In prehistoric archæology there are any number of sites awaiting excavation, and it seems highly probable from finds that have been made in Bihar that the Mohenjodaro civilisation extended not only to the Indus valley but to the valleys of the Jamuna and the Ganges as well. We do not yet know the meaning of the ideographs used by the people of the Mohenjodaro civilisation, nor what was the language used. It seems likely that it was a Dravidian tongue, but it might conceivably have been a Munda one. A mere reference to Munda is enough to remind one that our serious lack of knowledge of the distribution of this language shows how great is the necessity of linguistic research in southern India. Sir George Grierson's great work on the languages of India did not include the province of Madras, and we have no knowledge whatsoever of whether any trace of the Munda or Mon linguistic family exists south of the Godavari river or not. I suspect myself that such traces will be found in the uplands of Mysore, but that is a pure guess. An extension of the linguistic survey to the whole of south India is urgently needed; meanwhile we cannot tell whether the Munda speakers ever penetrated to the south or not, nor what traces, if any, survive of any of the languages that must have preceded Dravidian there. But we ought not to be content with mere linguistics. There is a branch of research in which so far as I know very little indeed has been done in India, but which if taken up comparatively is likely to lead to valuable results. I refer to the symbolism of dreams. Such work as has been done on this subject in Europe tends to show that the symbols of dreams are of universal application. Thus to dream of the loss of a tooth foretells the death of a relative in all parts of the world; most often, but not necessarily, it refers to a maternal relative, which is perhaps in itself significant. Now Freud makes a suggestion that the dream symbols used by the 'subconscious' to avoid the censorship of the 'ego' may be the survival of a symbolic language in use by the human race before any language, as we understand the word, developed. It seems not unlikely that when primeval man got beyond the stage of chattering, squealing, and grunting in different tones of voice, he communicated by means of a very limited vocabulary in which one word or symbol had to serve all sorts of different meanings connected only by some real or suppositious similarity in the objects named. The suggestion is an interesting one, and I would recommend a comparative research into the dream symbols of various castes and tribes as one which might throw some light on the pre-existence or otherwise of such a symbolic proto-language, and which would at any rate test the claim which has been made that dream symbols are of universal application. It has to be borne in mind of course that conventional interpretations of dream symbols may have been communicated, at a much later stage in human evolution, from one people to another in the manner in which folktales have spread all over the world, and that the diffusion or universality of conventional interpretations of dreams is not necessarily relevant to the hypothesis put forward by Freud, in which the symbol is used by the subconscious self in cases in which the ego disapproves and suppresses the use of a more easily recognised vehicle of expression

—Here the interpretation is not available until supplied by psychologists.

In the study of folk-lore proper only a beginning has been made in India, and a vast deal of material is disappearing very rapidly under the influence of missions and of the general change in the manner of living which is being brought about by the opening up of communications generally. Dr. Bake, a Hollander, has recently been working at Indian folk-music and has shown us what *can* be done by an enthusiast, while Bengal has set an example to other provinces in a revival of folk-dancing.

Turning to religion we find in India beliefs and practices which seem to have survived from a very early date in human history like flies preserved in lumps of Baltic amber. Thus traces are easily found, not only in tribal beliefs, in which the principle is sometimes specifically formulated, but in folk-religion as distinct from orthodox dogma, all over India of a belief that life is a finite and material substance. It is this belief in the transferability of life, so to speak, that underlies the practices of head-hunting and human sacrifice, though in the case of the latter the ideas of propitiation and expiation have doubtless entered later at a sophisticated stage when the original idea which gave rise to it had begun to fade. It also underlies many funeral practices in this country which are arranged with a view to the transference of the life-matter to the crops, whereby it is again consumed by human beings and used for the propagation of fresh individuals by the begetting of off-spring. Elsewhere I have pointed out that the same idea appears to be the basis of the practice of temple prostitution. Now I suggest that this idea of life as a material substance arose very early in human pre-history. Primitive peoples to this day have great difficulty in expressing anything but a concrete idea; primitive languages are apt to contain no words for abstract ideas. Clearly the inference is that at a primitive stage of thought only concrete things can be conceived of, and the first man who reflected upon the difference between a dying body and a dead one conceived of that which had left the body as some material substance which had leaked out of it, which is very much how the Karen states the case at this day, while this view of the nature of life is not only common throughout India in tribal religions but may be traced in Hindu philosophy. The Vedanta conception of the soul with its successive sheaths is probably one instance, and a more concrete one is to be found in Manu's condemnation of the Teli and his relegation of him to an outcaste position on the ground that he is a destroyer of life by crushing the oilseed for the extraction of oil; hence the distinction in Bengal between the Teli who crushed the seed and are therefore outside the pale and the Tili who merely traded in it without having committed the sin of destroying life. Another instance of the way primeval things survive in India is perhaps to be found in the common prejudices in regard to red ochre. When arranging for the numbering of houses in the 1931 census I found that red ochre was a desirable pigment to recommend because almost all over India the use of red ochre is regarded as fortunate, and while people are likely to object to numbers tarred or painted on their houses, the affixing of numbers in red ochre was regarded as more lucky than unsightly. I do not know the cause of this and I do not know that anyone knows why this superstition attaches to red ochre, but it struck me at once that it might well be a survival of some belief that was obviously at work in the old stone age. It is clear from many prehistoric finds that Palæolithic man treated the bones of the dead with red ochre and the find at Offnet of a large number of heads so treated without the appropriate skeletons suggests that the use of ochre may have at one time been associated with the practice of head-hunting or with that of a separate disposal of the head in burial, a practice still popular in parts of the hills of Assam, where it was once more prevalent than it is now, in parts of Burma, of Indonesia and of Melanesia.

I have said enough to indicate I think the enormous field there is in India for anthropological research. What is most wanted at present is the organised collection of facts, of facts, that is, uncoloured by any preconceived ideas. Facts once collected and put on record can be interpreted at any time, while premature interpretation is too apt to predetermine the actual facts collected, and all the time precious material is disappearing at a rapidly increasing rate. The tremendous change which motor transport has introduced into India has only just begun to be felt, but the general improvement in means of communication is indicated by a rise in 1931 in the figures of every form of road transport except those of palki-

bearers, who show a not very remarkable decrease and a rise in the figures of persons employed in the construction of means of road transport, and a corresponding rise of over 300% in the figures of owners, managers and employees connected with mechanically driven vehicles. This change is having an incalculable effect on country districts and you must expect to find that an incredible quantity of traditional belief and custom will disappear in a generation. Change has been fast enough in Britain. I can remember as a child taking part in more than one Easter egg-rolling, and you may search very far before you can see one there now-a-days, and I can remember watching the performance of what must have been one of the very last bands of the old folk sword-dancers before the artificial revival of folk-dancing; but in this country I have seen whole villages entirely abandon their ancient customs in the course of a few years, and there are no written records by which the rising generation of such villages can have any knowledge at all of the practices of their own fathers. It is therefore to the collection of the existing material of folk tradition before it is lost that this generation of Indian ethnographers is called and I would further urge that intensive work on a limited area is far more valuable than extensive work which necessarily involves generalisation. That can always be done later. Local differences are often very great and the minor differences found from district to district may be of great significance. Different areas with different environments need different treatment, and it seems to me that we suffer much, too much already in India from too much centralisation, and too much generalisation in every form of activity.

The question is likely to be asked what, if any, is the practical value of a study of anthropology. I offer no categorical answer to that question, but I do offer a few instances in which its practical value is sufficiently obvious. Thus in Africa the substitution of Indirect Rule for the older system of direct administration is the immediate result of applied anthropology. Indirect Rule is an educative system and its objective is to evolve by a natural process an indigenous system of administration which shall conform to civilised standards without jettisoning what is good and environmentally suitable in the native systems which Direct Rule must completely obliterate. To quote the Report of the Kenya Land Commission:—"The principle is that it is better to take the native customs as they stand and build from them as a basis, than to rely upon some novel but imported pattern which would not be understood—." Such a principle involves of course not only the knowledge of what is but of what has been; the knowledge of the origin and *raison d'être* of customs and belief, since no complete understanding of these is possible without the knowledge of how and why they came into existence and developed as they did. The experiences of Africa have an important bearing on the administration of the more primitive parts of India, and it would probably be wise in our administration of tribal areas to look for light not from the east but from the dark continent. *Semper aliquid novi Africa adfert*, and although the system of Indirect Rule has lately incurred much criticism and may in some cases have been carried too far, we have had only too little of it in India. Anthropologists have been accused, incidentally by Mr. Jayaker, of wishing to create for their own edification living museums of people whose sophistication is retarded to their disadvantage. In point of fact this criticism is most unjust. What the anthropologist does seek to do is to apply his acquired knowledge and experience so to modify contacts between primitive and advanced cultures that the former may not be, as they so often have been, ruthlessly extirpated by the latter, a process invariably accompanied by the decimation, if not annihilation, of the races whose culture is destroyed.

At the same time the answer to any question as to the practical value of anthropology must obviously depend to some extent on the circumstances under which the question is asked, and in the case of this country I would suggest that, apart from any administrative question, anthropology may be able to provide a solution of certain problems of very great importance to the people of India. India shows a marked contrast to Europe in that the number of males exceeds the number of females; various explanations have been sought in differences of climate, differences of race, or differences of social custom, but no one has yet studied the subject so thoroughly as to be able to offer us any convincing explanation of the phenomenon.

Again, it is for the anthropologist to consider and determine not only its causes but what will be its results. It is both contended and disputed that in-breeding leads to an excess of masculinity. If that be true (and there are weighty opinions on that side) then the caste system is likely to be one factor in producing this excess of males. If so, will such an excess have a good result or a bad one? In the former case caste is clearly an institution to be cherished; in the latter case we ought to do all in our power to encourage intercaste marriage. Here is a problem for the examination of anthropologists, a research problem of very great practical importance. It is not so much for the anthropologist to say whether or not an excess of males is a bad thing, as to determine the causes and consequences of such an excess; to say whether the observance of caste is a factor therein and whether intercaste marriages tend to produce a more even balance of sexes. An enquiry of this kind should not be an impossible matter in a town like Calcutta. Sir John Megaw, in a much discussed paper read last February before the East India Society, emphasised 'the urgent need for the people of India to adopt a new outlook on life'. Such a new outlook can, I claim, be supplied by anthropology, which should teach us to 'see life steadily and see it whole'. Life is very largely governed by custom and prejudice, and often so rigidly that these factors amount to tabus, for tabu in its broader sense is no foible confined to savages but an attitude of mind which they share with the most civilised, and which is common to all religions which depend on any hierarchical organisation or any schematic creed. Untouchability as observed in India is a precise instance of tabu. Tabus when they arise, may be admirable and even necessary, but like all religious dogmas tend to survive long after the necessity has declined and their moral justification has vanished, a survival which is often to the moral, social, or economic detriment of the community which holds them. Many instances of this might be given but it will be enough here to mention a tabu on the planting of rice in certain Naga villages. Where agricultural operations are carried out very largely by the work of the community acting together, it is obviously necessary to control the inception of successive stages, and to maintain their control a tabu is laid upon sowing and upon transplanting before the controlling official gives the word by an inaugural ceremony. Otherwise there would be a tendency for those whose fields had completed one stage with the help of their neighbours to go on to the next instead of helping the rest of the community to achieve a similar completion first. The successive operations of the agricultural year are therefore all governed by a series of ceremonies and tabus, the inauguration of which has been fixed at the time which experience has shown to be most suitable in the environment. So strong has the respect for these inaugural tabus become, that people migrating from one area to another have frequently continued to refer to the village of their origin for the dates of the ceremonies to be performed in their new village, and have thus perpetuated an agricultural calendar which is not suited to the changed environment, and although they themselves recognise that at their new and, for instance, lower and warmer altitude an earlier sowing or transplanting would be advantageous, they prefer from religious or superstitious reasons to retain the dates suited to the village of their origin and to suffer considerable economic damage as a result. Similarly the system of *tabu* was probably essential to the authority and position of the Maori chiefs, but so strong was the prohibition on touching one that a case is on record of a chief who was rescued by a missionary on the point of suffocation from a fish-bone stuck in his throat which none of his people could remove on account of that tabu.

Now the reason why tabu, useful in origin, is carried to an extreme which is merely damaging is that it has a definitely religious sanction, and all religious sanctions tend to be not only dogmatic but extremely rigid. This rigidity is no doubt a quality necessary to their enforcement to the first instance and to their survival of their initial inconveniences. At the same time its ultimate effect is to take such injunctions as, for instance, 'what God has joined let no man put asunder' and 'thou shalt not commit adultery', and interpret them so stringently as to make them prohibitive of divorce or of the remarriage of widows under any circumstances at all, giving us a stone for bread.

Professor Haldane has recently drawn attention to the fact that human morality is usually relative. He refers to that father

of modern science Aristotle, who, he says, 'saw clearly enough that right and wrong are usually quantitative. Thus according to the amount of risk taken in a given situation, conduct is judged to be cowardly cautious, brave or rash. There is an optimum somewhere between two extremes just as there is an optimum temperature for a growing plant.' He goes on to point out that the principle is 'perfectly familiar in science, as when a substance exhibits new properties with rising temperature, or an aggregate of many similar molecules displays characters not found in a single one.' The conclusion he draws is that a human code of ethics must be plastic and capable of adjustment to changes in the economic structure of society, and a code which is rigid is a dangerous anachronism. It is, however, the tendency of all hierarchical codes to aim at rigidity regardless of environment. It is just that spirit which, to use two more of Professor Haldane's illustrations, induced British bishops in the early 19th century to vote in the House of Lords against a bill to abolish the penalty of death for stealing by children under 16, and in this 20th century to oppose the legitimisation, by the subsequent marriage of their parents, of children born out of wedlock. It is the same spirit which is abroad in India opposing changes in the marriage laws or the entry of exterior castes into temples. Because a mediæval widow must burn with her husband or live celibate till her death, her remarriage is still discountenanced; because a thousand years ago it was considered advisable to marry off a daughter before she reached puberty therefore it is a sin not to do so to-day. There is ample evidence that the relative proportions of the sexes at certain ages differ in India from those in Britain largely on account of the great mortality among girls who are married and caused to bear children before they are physically fit for it. Yet the Sarda Act is a dead letter and the interval between its passage and its taking effect was used to perpetrate an enormous increase in infant marriages, not only among Hindus but also among Muslims and Christians. A careful investigation into the causes of death in childbirth in Madras showed that in 6% of *all* confinements the mother was under the age of 15, and if any one needs light on the excessive mortality among Indian girls aged between 15 and 30 he has only to turn to the Report of the Age of Consent Committee and the horrid volumes of evidence attached. Clearly there is need for the new outlook referred to by Sir John Megaw, particularly in the more rural parts of India.

Another end which I believe that anthropology can further, is that of a better understanding between nations and races. Nor do I refer merely to the very obvious need of a mutual understanding between Britons and Indians. Misunderstandings exist no less between different racial and social elements within India and are in just as much need of liquidation. It is a commonplace that to know all is to understand all, and clearly a knowledge of the characteristics and genius of an alien race as determined by their composition, their history and their environment is likely to make it easier to allow for points of difference and to appreciate by standards that are other than our own. The increasing ease and rapidity of communication is causing the world to shrink with a speed which is very disconcerting, and unless we can learn to put up with, as neighbours, peoples and nations that were merely names to the bulk of our forefathers we shall find it an uncomfortable place to live in. Change is proceeding at a pace that rapidly increases as it goes along, *vires acquirit eundo*, and although in India it has been extraordinary slow in the past, it is already very much faster and may become extremely fast in the near future. The geographer Ptolemy writing nearly two thousand years ago referred to the Nagas and placed them on his maps approximately where they are to-day, but though the name remains, he would no longer recognise their country as the realm of the naked, though this change has been taking place only in the last few years, and may not yet be regarded as complete. But nearly everywhere in rural India the last 20 years has witnessed a tremendous change in the standard of living and a very rapid introduction of new ideas and new practices. *Tempora mutantur et nos mutamur in illis*, 'times change, and we to fit them', may still be true, but for a great many of us the change is becoming too rapid to be at all comfortable, and there is real danger that the more backward may be entirely destroyed by failure to adapt themselves to the changed environment. What the anthropologist seeks to do is to control their contacts with a more sophisticated civilisation in order that they may have a reasonable chance of

adapting themselves to a changed environment and escape that complete destruction by disease and vice that contact with civilisation has brought to so many people of comparatively primitive economic culture. The object is not to chain the individual to his existing environment, but by giving him the opportunity to adapt himself to changes at his own rate to enable him to control his environment by the development of his own culture. The attempt to 'civilise' has generally meant an attempt to make in a hurry a perfectly good savage into an unsatisfactory or useless imitation of an inferior Bengali or an inferior European, unsuited to the surroundings in which he finds himself and able only to subsist as a parasite on society if he can be found what Nagas describe as a 'sitting-eating job'. It is against this process in any of its many forms that anthropologists seek to take precautions, and it may be claimed that at least in Africa they have effected something, and I am one of those who think that it is still not too late in parts of India and Burma, and that we can do no greater harm to people who have a culture of their own already adapted to their environment, than to filch it from them, before they have any means of appraising comparative values, by the substitution of another, unsuited to the environment and disguised under the insidious pretext of "uplift", which so often merely substitutes new tabus for old, while leaving the attitude of mind, the outlook on life completely untouched. The only case I know of in which the mere museum-of-exhibits policy could be justified is that of the Andamanese, who are probably so far removed from the conditions of modern life and from any qualifications for sharing it, that it is to be doubted whether adaptation is at all possible, without completing the destruction of what is left of them in the process. Fifty years of contact with the penal settlement in Port Blair has already reduced their numbers from over three thousand to a mere 450. A strict isolation is probably their only chance of survival, and they really ought to be preserved from extinction if only as scientific specimens of a type of human being elsewhere long vanished from the face of the earth.

Finally, anthropology like any other science is worth pursuit for the sake of knowledge alone. Great advances have been made in those sciences which give us knowledge of our environment. Geologists can tell us the composition and history of the earth and astronomers penetrate yearly further into space. Great advances have likewise been made in the sciences such as chemistry and physics which give us control over material substances and physical forces —but the merest beginning has been made in those sciences which give us knowledge of ourselves, a knowledge without which we can never hope to control the destiny of our race. The science of anthropology is the first step towards the acquisition of such knowledge. It has taken man about a million years to reach his present state of existence, and Sir James Jeans estimates that the earth will remain habitable for a million times that period again. What the human race will be like if it survive to such an æon, is clearly beyond the imagination of man, but one thing may be taken as certain and, that is, that will need all the knowledge it can have of its past and its present, of its nature and composition, and of the controls, if there be any, of its own development, if it is to succeed in adapting itself to the changes inevitable in so great a period of time. It is impossible to say what trifle may not lead to important discoveries, or that knowledge of no practical value to one generation may not be invaluable to the next. Meanwhile much material of great importance to anthropologists is disappearing all too rapidly, and we must search for knowledge and for truth while there is yet time. A philosopher of old has told us that Truth is great and shall prevail. Gentlemen, that philosoper was very clearly one great optimist, but even though we may see small sign of the prevalence of Truth in our generation it is all the more our duty as scientists to do all that in us lies to make her paths straight.

# Sectional Addresses.

AGRICULTURE.

*President:* DR. F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S.

## INDIAN AGRICULTURE AND PLANT BREEDING.

ALTHOUGH much valuable work has already been done on breeding for increased yields and improved quality, very little systematic work has yet been conducted in India on breeding for resistance to disease. This is a very important line of work and would require the careful attention of plant breeders in the future.

One of the recent successes achieved at Pusa is the production of new types of *rahar* (Pigeon pea—*Cajanus indicus*) that would resist the wilt disease caused by *Fusarium*. The resistant hybrids are rather unique in that they possess the same morphological characteristics as the type which is susceptible to disease. The yield and the quality of wheat have been greatly improved by the work of the Howards at Pusa, but the problem of making it resistant to disease is still awaiting solution. There is perhaps no crop in India which suffers such heavy and consistent loss as wheat does from rust. A comprehensive scheme of work has therefore been undertaken by the Imperial Agricultural Department and it is hoped that fruitful results will soon be obtained. Extensive investigations have been carried out on linseed with the object of producing a white or yellow seed of high oil content and good yielding power. The results already obtained are not only of much practical interest but are also of considerable scientific value. Potato is another economic crop on which much systematic work has yet to be done for improving resistance to insect attack as also to fungus and virus diseases. On the plains there is considerable loss through fungus and bacterial diseases. The problem of storage has also not been solved satisfactorily. The varieties become degenerated and fresh seeds have to be obtained from time to time from the hills. On the hills, the crop is liable to blight from which the plants on the plains are generally free. Work has recently been undertaken at Pusa to study the distribution of different varieties of potato in India; to procure new varieties from South America and to cross them with the best Indian varieties for securing immunity or high resistance to blight, fungus and virus diseases; and to study the factors influencing flowering and fruit development as also those which might lead to the breaking of dormancy in the tuber. The most important achievement in the breeding of cane is the success achieved by Rao Bahadur T. S. Venkataraman and his colleagues in bringing about intergeneric cross between sugarcane and sorghum. Although it is premature to forecast the practical significance of that work, it would yet appear that one of the crosses (CO 352) appears very promising, ripening in six to seven months and maintaining its juice for another three months.

The physical mechanism of heredity lies in the cell and its chromosomes and a wealth of material awaits the investigator who can study the numerous crops which have been and are now subject to genetical research in India. The Central Agricultural Research Station which will soon be developed at Delhi will have a cytological section attached to it, but there is so much of work to be done that it may be hoped that the different Universities in India will also take active interest in that line of research and thus form fruitful link with the workers on the field.

There is a limit, however, to the extent to which the breeder can improve crop yield. The general soil fertility would be the limiting factor and it is necessary that if we are to obtain high yields of crops, we should also improve our methods of cultivation. The labours of the workers in the different branches of science are equally important in the advancement of the oldest and the most important industry in India.

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PHYSICS AND MATHEMATICS.

*President:* DR. N. R. SEN, D.Sc., Ph.D.

## THE DEVELOPMENT OF MODERN THEORETICAL PHYSICS AND ITS LIMITATIONS.

A COMPARISON of the physical ideas of the days of Galileo and Newton and later of Laplace, Poisson, Coulomb, Oersted, Gauss and Weber on the one hand, and the modern microphysics with its Wilson chamber, quantum jumps, electronic phase wave and uncertainty relation on the other, shows that the construction of a bridge across the gap between them is well nigh impossible; all the same, there is a continuity between the old and the new. Thus in the newest Wave Mechanics the dynamical forms of Hamiltonian mechanics are preserved, while the Correspondence Principle of Bohr was avowedly an attempt to preserve some of the aspects of the older theory such as were not in contradiction with experiment.

In Newtonian mechanics the Laws of Motion and the Law of Universal Gravitation were the two central points which, however, had no interconnection and the equality of gravitational and inertial mass was only accidental. The Theory of Relativity, on the other hand, saw a unifying principle in this equality and developed a new Theory of Gravitation. Before this theory came, the science of mechanics ruled men's outlook on the external world, and attained a highly developed state at the hands of Lagrange, Hamilton and Jacobi. Another forerunner of the Theory of Relativity was the science of Electrodynamics. Maxwell's Field Equations, receiving a beautiful confirmation at the hands of Hertz, culminated in the advent of the Electron Theory of Lorentz, thus providing an Electrical Theory of matter while an earlier generation had sought to develop a mechanical theory of electromagnetism.

Summing up, the field theory succeeded in connecting electromagnetism with optics, generally identified the electron as a fundamental ingredient of matter and furnished a theory of Radiation which, apart from the question of the production of radiation and the distribution of energy in it, was found quite satisfactory. But there were a number of difficulties such as the constitution of the ether and a theory of the electron. The electron was found to require an infinite energy-content if it was thought of as a point charge, while when it was thought to have a definite radius, its energy and momentum did not

satisfy the usual relation between momentum and energy so that a part of its energy had to be thought of as non-electromagnetic. Poincaré also showed that a definite mechanical pressure on its surface was necessary if it were not to blow up.

While the laws of mechanics are invariant with respect to a Galilei transformation, the field equations of Maxwell are so only with respect to the Lorentz transformation. The Theory of Relativity was led to the validity of the Lorentz transformation even in mechanics by considering that time was also relative, and when the mathematical formulation of this was developed by Minkowski it was found that space and time were different aspects of one entity space-time. The successes of this theory led physicists to require invariance under the Lorentz transformation as the criterion of a correctly formulated natural law.

The Field Theory was found quite inadequate to explain the structure of the atom and its radiative properties. The existence of a line spectrum was incompatible with a stable atom if the radiation was supposed due to an accelerated electron. The sharp limit of the continuous spectrum of an X-ray tube, the dependence of the velocity of photo-electrons on the frequency of the incident light and the distribution of energy in the spectrum of a black body were each one of them in contradiction with the Field Theory and were explained only when the Quantum Theory was introduced. The most fruitful application of the quantum hypothesis was made by Bohr in his explanation of the emission of line spectra by stable atoms. His assumption of discrete energy states was confirmed by the experiments of Franck and Hertz, while his theory of spectra was extended and an explanation of the fine structure of optical and X-ray doublets and of the Zeeman effect was given by Sommerfeld. In all this work the mechanics of Hamilton and Jacobi was employed but an *ad hoc* quantum condition was super-imposed.

Heisenberg started with the object of excluding all unobserved quantities from the theory and was led to his Matrix Mechanics which removed a number of difficulties in the old Quantum Theory and dispensed with the *ad hoc* introduction of quantum conditions. The hypothesis of Uhlenbeck and Goudsmit that the electron has a spin moment of $\frac{1}{2}\times\frac{h}{2\pi}$ and a magnetic moment $\frac{eh}{4\pi mc}$ due to this spin, together with Pauli's exclusion principle that no two electrons can have the same set of quantum numbers, led to an explanation of fine structure, the periodic table and the anomalous Zeeman effect. The quantum mechanics makes use of non-commutative algebra and Dirac considered two types of numbers, the ordinary scalar numbers called $c$ numbers and the quantum numbers or $q$ numbers which are subject to special rules of calculation.

Very different in appearance but identical in the final results was the Wave Mechanics of Schrödinger which was based on de Broglie's idea that matter particles are associated with waves—an idea fully confirmed by the experiments of Davisson and Germer and of G. P. Thompson. Schrödinger's method is that of differential equations and eigenwert problems; the possible energies of the discrete states of the atom correspond to the eigenwerts of a differential equation which is really a wave-equation. Though this appears to establish a connection with the continuous theory, the later interpretation of the $\psi$-function leads to very different results. While in Classical and Einstein's Mechanics the position and momentum of a particle are quite determinate and any subsequent state can be predicted from the initial state, the dynamical variables in the new Wave Mechanics have no definite values but only a number of possible values with a certain probability for every one of them. Accordingly, the wave phenomenon associated with the probable values of dynamical variables has been called a Probability Wave.

This indeterminism is intimately connected with the uncertainty principle of Heisenberg according to which the errors $\Delta p$ and $\Delta q$ in the measurement of the simultaneous values of the momentum and position of a particle are such that $\Delta p . \Delta q$ is at least equal to $h$ which is Planck's constant. This impossibility of reaching accuracy in both position and momentum coordinates is due to the fact that the physical process of measurement best suited for a determination of one of these introduces an unknown alteration in the value of the other. This is often described as a breakdown of the Causal Principle and has led to much discussion. While a Law of Nature states what particular event belongs to a given cause as its effect, the Principle of Causality states that a definite cause will have a definite effect. In the opinion of Planck who is a staunch supporter of Causality, an event is subject to Causality when it can be predicted with certainty. But infallible prediction is not possible in any case so that Causality has to be defined in a different way. In order to avoid the uncertainties inherent in every measurement the laws of Nature are supposed to hold exactly in an ideal world and the translation from such thought processes to the world of sense perceptions is supposed to be the origin of the uncertainty. But in quantum physics even this ideal process is shown to be subject to uncertainty. Accordingly Planck imagines a "Geist" who can perceive all details and can make certain predictions. Summing up, he says, that Causality is neither true nor false, but is a sort of heuristic principle which science must use in order to obtain fruitful results.

Schrödinger's non-relativistic wave equation with one wave function succeeded in reobtaining all the previous results in the one electron problem and in setting up a theory of dispersion and scattering. But the fine structure of alkali atoms came out wrong and there was no counterpart of the idea of spin. Besides, it was not invariant under the Lorentz transformation. Pauli in 1927 introduced two wave functions to correspond to the two values of the spin $\pm\frac{h}{4\pi}$. Dirac showed that using four wave functions the equation for the electron can be set up so as to have Lorentz invariance. The essential features of this theory are a current density vector satisfying the conservation principle and the existence of spin and magnetic moments of the electron.

Dirac also gave a theory of the radiation field. Since then attempts have been made to build up a quantum electrodynamics. The theory of Heisenberg and Pauli gives the classical results

but the self-energy of the electron comes out as infinite. The same difficulty occurs in a theory due to Dirac. The attempts of Klein and Jordan were also unsuccessful and Oppenheimer was able to show that the energy of interaction between radiation and the free electron also tends to infinity. Dirac's theory contained another difficulty, *viz.*, the existence of negative energy states. These were shown to be essential to the theory as when the Klein-Nishina formula is deduced therefrom. An attempt by Schrödinger to eliminate the negative energy states had to sacrifice the Lorentz invariance of Dirac's equation. Another difficulty is the conclusion reached by Klein that electrons of kinetic energy E, when they meet a potential barrier such that $eV > m_0c^2 + E$, can still pass through and turn up on the other side in the negative energy state. Sauter showed that an electron passes into the negative energy state if the potential changes by $\frac{m_0c^2}{e}$ within a distance $\frac{h}{4\pi m_0 c} = 1 \cdot 6 \times 10^{-11}$ cm. The radius of the nucleus being less than this, electrons, if they can exist inside the nucleus, do not satisfy Dirac's equation. Dirac has sought to overcome the difficulties of the negative energy states by assuming that they are almost all occupied and that an unoccupied hole behaves as a positive charge and that when an electron falls into such a hole, it will dematerialise and give rise to two quanta. Even in this theory the self-energy of the electron is infinite and Dirac has made an attempt to overcome this difficulty by breaking up his operators into two parts and requiring that the part which leads to infinite self-energy should be omitted afterwards. But the principles of the conservation of energy and momentum break down in this theory as pointed out by Furry and Oppenheimer who also show that the theory is applicable so long as frequencies of the order of $mc^3/e^2$ or lengths of the order of $e^2/mc^2$ (radius of the electron) are not involved.

Another difficulty connected with the New Mechanics is that the loss of energy of electrons of initial energy $300 \times 10^6$ $eV$ on passage through a centimetre of lead comes out from Bethe and Heitler's theory after all corrections have been made to be at least four and a half times the value found experimentally by Anderson. Though Dirac's theory is relativistic, the time appears in it in a different way from the space coordinates. A further difficulty of a fundamental nature pointed out by Landau and Peierls is that according to their calculation the uncertainty in the measurement of an electric field E is $\Delta E > \frac{\sqrt{hc}}{(c\Delta t)^2}$ and the idea of a photon itself is somewhat illusory. These difficulties still await an explanation.

Nuclear physics has advanced largely in recent years on account of the discovery of the neutron, the deuton and deuterium and the positron. Theorists have been confronted with a determination of the structure of the neutron. The view that it is made up of a proton and an electron leads to difficulties as also the view that it is a fundamental particle and that a proton is made up of a neutron and a positron. In the former case the fact that there is no solution to the wave equation with an orbit less than the first Bohr orbit presents a great difficulty, in the latter the positron will have to be assumed to have no spin and then the annihilation of an electron and a positron becomes unintelligible.

In all calculations regarding the conversion of one nucleus into another by bombardment and emission of particles the laws of conservation of energy and momentum and the Relativity principle of the mass equivalent of an energy E being $E/c^2$ have all been found to hold. Only in the case of $\beta$-disintegration there seems to be a violation of the energy principle in individual elementary processes. Bohr has pointed out that although the energy principle may be taken to be statistically valid, even then there will be difficulties. Pauli has tried to remove these difficulties by assuming the existence of neutrinos which, however, have not yet been observed.

Regarding Corpuscular and Field Theories of matter, Einstein and other eminent philosophers believe that a single field theory can account for all the facts. The first success of the general Theory of Relativity was the unification of the laws of motion and gravitation. Weyl and Eddington then tried to unite electromagnetism and gravitation in a unified field theory. Kaluza was able to do this by introducing a fifth dimension which, however, does not correspond to anything in physical nature. Einstein and Meyer have tried to develop a four dimensional unified field theory on the basis of the work of Kaluza. Einstein tried to explain the existence of a particle such as the electron in terms of his field theory but though he succeeded partly in doing so, his theory predicted the existence of electrons with all possible charges contrary to experience. The newest attempt in this direction is that of Born and Infeld who have revived a theory due to Mie in an improved form, and the existence of a point electron with finite energy has been found to be consistent with the theory. The success of this theory has been large and one awaits its extension to include quantum phenomena. On the other hand, there are physicists who believe that quantum phenomena cannot be brought into harmony with a continuous field theory and are trying to develop a quantum electrodynamics. The future alone can decide which of these ideas is going to give us a key to the secret of Nature.

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## CHEMISTRY.

*President:* DR. A. C. SIRCAR, M.A., PH.D.

### RECENT WORK ON THE HIGHER COAL TAR HYDROCARBONS.

IN his Presidential Address, Dr. Sircar gives a review of recent work on higher coal tar hydrocarbons especially acenaphthene, fluorene and phenanthrene. The discovery of a number of commercially important dyes among derivatives of acenaphthene has stimulated research in this group. In the benzene and naphthalene series, numerous products which have got any technical application as dyes, drugs, etc., are all substituted derivatives whereas in the case of the higher coal tar hydrocarbons, the quinones and their derivatives are of more value. The halogenated acenaphthenes can be oxidised to the corresponding acenaphthenequinones which give rise to valuable dyestuffs. The most important dyes in this series are probably the vat dyes obtained by the condensation of acenaphthenequinone with

hydroxythionaphthene and related compounds which are used for dyeing cotton or wool giving yellowish red to greyish black shades of extreme fastness. When halogens are introduced into the acenaphthene nucleus an added affinity for cotton together with light fastness and intensity is developed. Sircar and Rajgopalan (*J. Ind. Chem. Soc.*, 1932, 9, 639) have obtained numerous vat dyes by condensing acenaphthenone with aromatic aldehydes, thus extending the work of Graebe and Jequier (*Ann.*, 290, 195). Sircar and Guha (*J. C. S.*, 1924, 335) have described the azines obtained by condensation of acenaphthenequinone with orthodiamines which dye wool in brownish yellow to greenish black shades, and also oxazoles and iminoazoles obtained by condensation with aromatic aldehydes. On an examination of the constitutional formulæ of the 619 important azo dyestuffs, it was found that most of them contained sulphonic acid groups which though having no effect on colour, enhance the solubility and help in the development of even shades on textiles. It is possible that a thorough investigation of the mono- and poly-sulphonic acid derivatives of amino hydroxy acenaphthenes may yield valuable azo colouring matters. The poly-nitro derivatives of hydroxy acenaphthenes may also be found to be as useful as polynitronaphthols employed for colouring soaps, spirit varnishes and foodstuffs.

Fluorene ($C_{13}H_{10}$) occurs in the fraction of coal tar boiling at 300–340° C. Its methylene group in 9 position is remarkably active and a large number of derivatives have been obtained through this position. Holliday and Hodgkinson (*E.P.*, 1884, 3730) prepared hydroxyfluorene by alkali fusion of monosulphonic acid and described some azodyes. The tetra-azo compounds from 2 : 7 diaminofluorene and its derivatives couple with phenols and amines giving dyes which can be utilised for dyeing cotton but have, however, achieved no commercial importance.

Little is known of the possible quinones derivable from fluorene. Fluorenone and its derivatives obtained by oxidation of fluorene, afford a good field for research and until recently no dyestuff had been prepared from fluorenone (*J. Am. Chem. Soc.*, 1923, 45, 3071). Sircar and his co-workers obtained fluorenone azomethines from 2-amino fluorene and aromatic aldehydes which though fairly deeply coloured were not suitable for dyeing. An attempt to prepare vat dyes from 2-amino fluorenone and dibasic acid chlorides also proved unsuccessful as the resulting fluorenoxylamides could not be made to yield soluble vats with hydrosulphite. Though satisfactory methods have been worked up for separation of fluorene in bulk from coal tar, no large-scale commercial use for the same has so far been developed. As with acenaphthene and anthracene, more interesting results have been obtained from the quinone of phenanthrene than from the parent hydrocarbon. A considerable amount of important work on dyes from phenanthraquinone is due to the late Dr. E. R. Watson and his school. They prepared polyhydroxy-, nitro-, and bromo-phenanthra-quinones, phenanthraphenazines but found their dyeing properties to be not very satisfactory. The anilinophenanthraquinones prepared by them produced dark-blue, green or black shades on wool. Their attempts to prepare vat dyes from this quinone were not successful. Watson and later Sircar described numerous azodyes from phenanthraquinone whic were found to be mordant dyestuffs givir brown to violet shades. The azomethine dy from phenanthraquinone were not found to l satisfactory for dyeing. The colour developed c the fibre by anilinophenanthraiminazoles w found to be influenced by the position of t anilino group, shades ranging even up to blui black being obtainable. Dutt (*Ber.*, 1933, 6 1226) has recently prepared a number of indigo vat dyes by condensation with hydroxythi naphthenes giving blue to greenish blue dyes.

Though a large number of phenanthraquino derivatives have been described very few them have as yet attained any commerci importance. Attention is drawn to the physi logical and therapeutic importance of the phena threne nucleus as shown by its occurrence the morphine group of alkaloids, in the stero the bile acids and even some of the hormones.

High temperature carbonization of coal is t main source of these higher coal tar hydi carbons. Dr. Sircar considers there is no reas to be discouraged if a continued supply of the products is threatened by a general adoption low temperature carbonization. He conclud his address with an optimistic note that in ca of scarcity the inventive genius of the technic chemist will produce these compounds on commercial scale employing synthetic metho already known, as has been done recently in t case of anthraquinone and methylanthraquinon

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## ZOOLOGY.

*President :* DIWAN ANAND KUMAR, M.A.

### SPICULES AND CLASSIFICATION OF TETRAXONIDA.

As early as 1900, Minchin classified the phylu Porifera (sponges) into Calcarea, Hexactinelli and Demospongia and of the four sub-class under Demospongia, Tetraxonida forms an in portant one. Five years later, Dendy divided t non-calcarea into 4 orders, *viz.*, Myxospongid Triaxonida (Hexactinellida), Tetraxonida a Euceratosa. The address before the Zoolog section is a chronological account of the spicul and classification of one of these important orde of non-calcarea, namely, Tetraxonida, where t fundamental plan of the spicule is tetraxon and tetractinellid. The learned president clain a certain amount of familiarity with the subje though he rightly points out that even here h can only speak "as a person, who has gathere information from different sources, rather tha as one with any authority." The spicules of t tetraxonid sponges are usually treated unde 2 categories megasclere and microsclere. Th former are skeletal in nature while the latter li scattered in the softer parts and according to Solla the larger forms are derivatives of the microscler Describing the Homosclerophera, an exhaustiv account of the spicules is given of the thre genera Plakina, Plakortis and Dercitopsis. I the last genus spicules with 2-rays upto pentact are noticed. This genus is possibly the pro genitor from which more complicated form must have evolved. The spicules in th species of Plakinidæ show various combina tions of forms of those met with in the above named primitive form and the mega and micro scleres become very prominent. Several form

of triænes (including some aberrant forms) of diactinal types are described. Under the microscleres, the astrose and sigmatose types are largely treated, giving a comprehensive account of the variations that these may undergo. The appearance of spines on these spicules is also mentioned. At the end the classification of this group according to various authors is appended.

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## BOTANY.

*President:* DR. J. H. MITTER, M.A., B.Sc., PH.D.

### FUNGOUS PLANT PATHOLOGY AND MYCOLOGY IN INDIA.

IN his Presidential Address to the Section of Botany Dr. J. H. Mitter has given an exhaustive account of mycological and plant pathological research in India.

He has traced the history of mycological work in India from 1825, which was mainly of the nature of collections, to the present day. The impetus to higher research in Plant Pathology in India may be said to start with the investigations of Dr. E. J. Butler, "the real father of Mycology and Plant Pathology in India".

The important rôle played by the Imperial Research Institute, Pusa, with Dr. Butler as the Imperial Mycologist can be seen by the large number of valuable publications. In the course of his address, Dr. Mitter has reviewed, more or less in detail, the investigations carried out on Plant Pathology at the Imperial Agricultural Institute, Pusa, and in the Provincial Agricultural Departments at Madras, Mysore, Baroda, Bombay, Central Provinces, United Provinces, Assam and the Punjab. The research work done by the Indian Tea Association and that by the Forest Departments in India are mentioned in review. One feels that he might have included the very valuable contribution on Coffee Research made by the Scientific Officers of the United Planters' Association, South India, at the Coffee Experiment Stations at Siddapur and Balehonnur.

At present some of the Universities, *viz.*, the Punjab, Agra, Allahabad and Calcutta, have taken up research on fungi. In considering the future of Mycology in India, considerable stress is laid on the need for co-operation between Universities and the Plant Pathologist, who has not always much time at his disposal to carry out the purely scientific work on the life history of the pathogen.

He has also suggested that the sons of rich zamindars should take up to Plant Pathology not only as a hobby but to increase the yield from their land.

These valuable suggestions of Dr. Mitter in the interest of Plant Pathology in India, will find a wider application for many other problems of agricultural research.

In conclusion, he has pointed out the desirability of establishing a bureau for stock cultures of fungi, and the publication of an up-to-date textbook on Mycology for India.

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## GEOLOGY.

*President:* DR. M. S. KRISHNAN, M.A., PH.D., A.R.C.S., D.I.C.

### THE DHARWARS OF CHOTA NAGPUR—THEIR BEARING ON SOME PROBLEMS OF CORRELATION AND SEDIMENTATION.

THE Presidential Address to the Section of Geology by Dr. M. S. Krishnan of the Geological Survey of India deals with a subject of considerable importance to Indian geologists, *viz.*, the correlation of the rocks of the Dharwar system and a discussion of the origin of some types of rocks found therein. The Dharwars of Chota Nagpur are divided into three series: The lower 'Metamorphic series' consists of much igneous and some sedimentary material, and is confined to South Singhbhum and the adjoining part of Keonjhar; the middle 'Gangpur series' is characterised by manganese ores of the gondite type and calcitic and dolomitic marbles; the upper 'Iron-ore series' is characterised by banded hæmatite-jasper with associated iron ores and basic igneous rocks, mainly sills and flows. On the basis of this classification, the Older Dharwars are to be looked for in the metamorphics of other parts of India. The Middle Dharwars comprise the Gangpur series of Bihar and Orissa, the khondalites and associated marbles and manganese ores of the Eastern Ghats region, the Sausar series, the Sonawani series and the lower part of the succession in Jubbulpore in the Central Provinces, the Aravallis and Champaners of Rajputana and western India, and the Sakarsanhalli rocks of Mysore. The Upper Dharwars will include the Iron-ore series of Singhbhum, the Chilpighat series of Bilaspur and Balaghat, the Sakoli series of Bhandara, the iron-ore-bearing rocks of Bastar, Chanda and Jubbulpore, and probably the greater part of the so-called Bijawars of Bihar. The Dharwars of Southern Bombay, Bellary, Mysore and Salem, in which typical iron-ore rocks occur, and possibly also the Delhi System of Rajputana, are to be included here. A concise description of the rocks of Bihar and Orissa and Central Provinces is followed by a discussion and a tabular statement giving the correlation suggested above.

The latter part of the address concerns itself with the description of the chief characters and a discussion of the mode of origin of a few types of rocks—the marbles, carbonaceous phyllites, manganiferous rocks and the banded ironstones. The marbles, which are to a large extent dolomitic, are regarded as chemical precipitates, but primitive organisms may have aided their formation. The Carbonaceous phyllites are held to be ordinary sediments, whose carbon content was derived from early organic matter, and not from a volcanic source. Similar carbonaceous rocks are found in the Salkhalas and Jutoghs of the Himalaya, and the Chaung Magyis and Merguis of Burma, the carbon content of all these being attributable to organic and not volcanic origin.

The manganiferous rocks comprise two types. The older gondite type is primary and the younger Iron-ore series type is secondary, as shown by Dr. Fermor in his well-known work on the manganese ores of India. These two types also occur in other parts of the world, and when both are found in the same region, as in Brazil, the

older which is also richer in manganese than iron, is of the gondite type.

The banded iron-ore rocks are briefly described and their constituents are held to be essentially the products of weathering under the conditions existing in the Pre-Cambrian era. The iron content cannot be regarded as of volcanic origin especially as the period of volcanism has been shown to be later than the period of their deposition. The carbonate and oxide facies of the deposition of manganese and iron ores have been controlled by physico-chemical conditions, among which the relative abundance of oxygen and carbon dioxide in the areas of deposition has played an important part. It is also suggested that the magnetite-quartz-schists of Mysore are of sedimentary origin and not igneous as held by the Mysore geologists.

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## MEDICAL AND VETERINARY RESEARCH.

*President:* MAJOR K. R. K. IYENGAR, M.D., D.P.H., I.M.S.

### RABIES.

RABIES has been known to mankind for over 2000 years. A considerable amount of time has been devoted to work in connection with rabies, but little of immediate value has been ascertained. All attempts to cultivate the organism artificially have failed, and all efforts to prepare serum and devise more efficacious means of prophylactic treatment than those in general use now have ended in disappointment. Until the organism has been cultivated artificially, it will not be possible to improve greatly upon the somewhat crude method which is now employed. All future research work on rabies should concentrate on the identification of the virus and its growth on artificial media. Once this is done, the necessity for so many Pasteur Institutes in India will not exist. One All-India Pasteur Institute, whose functions would be to manufacture the vaccine and to carry out research work, would be sufficient.

Last year, work was carried out at the Pasteur Institute, Coonoor, in order to find out the electric charge carried by the rabies virus and the method adopted for this purpose involved the use of electrophoresis. The experiments consisted in passing a 4-milliampere current through a 5 per cent. suspension of infected rabbit brain in sheep serum, and, after a time, samples collected at each of the poles were subjected to appropriate biological tests. It was found that the contents of the positive cell produced rabies on subdural inoculation to rabbits, while the contents of the negative cell did not. This clearly proves that the rabies virus is electro-negatively charged and migrates towards the positive pole, within certain limits of pH.

In view of the great difference of the virus-content of the different parts of the brain, the vaccine as used now can only be taken as a crude one. Now that we know that the virus has an electro-negative charge, we can isolate the virus in a pure form at the positive pole, thereby getting rid of the tissue proteins. This may be the means of preparing a more highly concentrated anti-rabic vaccine than has hitherto been possible. Further experiments as to the antigenic value of this vaccine as compared with that of the crude vaccine are in progress.

We have also found that the vaccine can be sterilized by exposure for 10 minutes to radiation from a quartz mercury lamp and the antigenic value of the vaccine so inactivated has in no way deteriorated. A mercury vapour lamp gives radiation of wave-length from 6500 A. U. to very nearly 1800 A. U., and there is evidence that the shorter wave-lengths of light, such as ultra-violet 4000 to 1800 A. U. are highly inactivating. This method of sterilizing the vaccine is a great advance on the present methods adopted by the use of chemicals, such as carbolic acid and formalin.

By far the largest proportion of persons who come to anti-rabic institutes for treatment have been bitten by dogs. Dogs must, therefore, be regarded as the chief agents in producing mortality from hydrophobia in man. Jackals inflict about 5 per cent. of the bites; cats a still smaller proportion: whilst other animals may be left out of consideration. If rabies amongst dogs were to be practically eliminated, not only would the greater number of deaths from hydrophobia in man be prevented, but also a large number of cattle and domestic animals would be saved. Stray dogs, when rabid, set up foci of infection here, there and everywhere, until they succumb to the disease.

It will not be possible to suppress rabies completely in a country like ours within a reasonable number of years, but it can be controlled sufficiently to reduce the annual mortality to an almost negligible quantity. Rabies primarily is a disease of dogs; only occasionally is it communicated to other animals and to man. It is a wrong procedure to treat cases as they arise and to take no steps whatever to control the dog population. Many anti-rabic institutes have been established for curative purposes, while preventive measures have been neglected. This is wrong in principle. Steps should be taken to deal with the disease at its source.

In Germany, rabies has been so successfully controlled that it is now regarded as entirely a frontier disease, that is to say, every case in man and animals can be traced to an importation, and rigorous preventive measures are promptly taken. In Australia, rabies is now unknown. In the British Isles, the muzzling order was introduced, followed by the quarantine of all imported dogs, and this has resulted in the eradication of the disease within a few years. At the time there was a public outcry against these orders, but yet the end justified the means, and persistence was crowned with success.

To control rabies, dogs must be controlled, and if any class or individual is beyond control, they must be gradually eliminated and not allowed again to come into existence. In this endeavour the State and the public are interested and earnest co-operation is necessary on all sides, if anything is to be achieved in the way of regulating the dog nuisance and the danger from rabies. Any scheme to be effective must have the hearty co-operation of all the authorities concerned. It would scarcely be worth while to attempt any measures of control, unless they were adopted universally in the land. All dogs which have no real owner who will accept any responsibility for them, are under no control and they must all be destroyed. There is a very large class of dogs which are attached to no

# SUPPLEMENT TO "CURRENT SCIENCE".

## Reviews.

THE THEORY OF UNEMPLOYMENT. By A. C. Pigou, M.A. (Macmillan & Co. 1933. Pp. 319.) Price 15s. net.

In a brief study of the problem of unemployment published in the Home University Library Series about two decades ago, Professor Pigou had examined the broad economic factors which govern the causation of unemployment, and discussed its remedies and palliatives. His main conclusions were firstly, that even in a stationary industrial state unemployment would be a necessary result, if the wage-rate, instead of being left to be adjusted by the free play of economic forces, is forced up either by collective bargaining through Trade Unions, or by humanitarian or legal compulsion in favour of a minimum wage; and secondly, that in the non-stationary conditions of real life, the rigidity of the wage-rate, the impediments to the nobility of labour, and the fluctuations in the demand for labour operate as additional causes for the production of unemployment.

The present volume deals with the same problem in a much more thorough and scientific manner, with a definite aim at such completeness as can be attained in the present stage of knowledge, and with all the precision and careful analysis which students of economic science have learnt to associate with the name of Professor Pigou. The various types of causes and economic situations relevant to the amount of unemployment are here systematically classified and listed, and in the investigation of each the analysis is sought to be pressed to the farthest feasible point. This new book must therefore be welcomed, not only for its great disciplinary value to the advanced student, but as a classic achievement which extends considerably the limits of economic analysis, and furnishes a basis and a scaffolding for future work.

It is also a matter for congratulation that Prof. Pigou has definitely decided in this new book to adopt mathematical analysis as the avowed instrument of economic investigation; indeed considering the nature of the subject-matter and the intricacy of the analysis, any decision to the contrary would have been inconceivable. Prof. Marshall, the predecessor of Prof. Pigou in the Cambridge Chair, in his *Principles of Economics*—and we may add, Prof. Pigou himself in his *Economics of Welfare*—created the fashion of dressing up private mathematical reasoning into elaborate non-mathematical language for the edification of the public. The clear advantage in discarding this pretence ("Cotton-wool", as the author aptly terms it in the Introduction) is that the certitude and clarity in the mind of the writer is communicated directly and without hindrance to the reader. One recalls in this connection the controversies about the applicability of mathematical reasoning to economics, in the early days when economic concepts were in the nebulous formative stage—controversies all the more violent as both the protagonists and the opponents often suffered from fundamental misconceptions. It was doubtless the desire to avoid such misconceptions that must have led Marshall to give the advice "to burn all mathematics" in his private correspondence, and must have been partially responsible for the suppression of the mathematical element in his work. However, this phase of economic science belongs definitely to the past. To-day the term 'mathematical economics' is a misnomer; there is, on the other hand, only one economic science, and mathematical analysis is the essential and irreplacable instrument of its reasoning and method. What in fact would remain of modern economics if demanded of the ideas of its great creators, Jevons, Cournot, Walras, Pareto—ideas, economic indeed in their content and significance, but mathematical in their form? The fact that most Indian Universities (who are generally content to stay, at a modest estimate, about fifty years behind time) have declared in favour of 'non-mathematical' economics, does not render it any the less true that economic science loosened from the ballast of mathematical reasoning, becomes degraded into vague statements, referring to the qualitative interdependence of various loosely defined economic entities, and leading nowhere in particular.

The book is divided into five parts of

which the last deals with the main theme, while the others prepare the ground by studying the precise relation of the quantity of unemployment to various other economic factors. Part I is devoted to preliminary considerations, to the precise definition of unemployment and to the relation of the volume of unemployment to the flow of wage-goods. In Part II a fundamental formula is obtained for $E_d$, the elasticity of real demand for labour in a single centre under competitive conditions, in terms of (1) the elasticity of demand in terms of wage-goods, for the new output at works of the finished products, (2) the elasticity of supply of the raw material, (3) the elasticity of the productivity function of labour, (4) the ratio of the demand price of the finished product to the price of the contained raw material, and (5) the ratio of the money-wage to the money value of the net output per head of the labour employed. The case of several centres of production, and the differences made by monopolistic conditions and by the rate of interest due to the deferred character of the return to labour are then examined. The elasticity $E_r$ of the real total demand for labour (that is, in the wage-good and non-wage-good industries together) is next expressed in terms of the elasticity of real demand for labour in the wage-good industries. The last chapter studies the money elasticity $E_m$ of the total real demand for labour, refutes the popular fallacy that $E_m = 0$, and derives a formula for expressing $E_m$ in terms of $E_r$, on the hypothesis that the total money income is a function of the total real income.

Part III defines 'improvements' in the supply of raw material, in the demand of the new output of the finished commodity, and in the productivity of labour, and studies the effect of such improvements on the real demand for labour, and the rôle of various factors, such as seasonal and other variations in people's desire, State stimulation, interrelations of utility between different commodities, etc., in producing fluctuations in the demand for labour. Several other aspects of the question, including the effect of change in the rate of interest, are also examined.

So far the argument has been from the 'real' end, that is, in terms of wage-good units, implying the use of an index for the cost of living or the general price level. Part IV studies the influence of monetary factors by means of a hypothetical standard monetary system, in which the aggregate money income varies only with the variation in the several factors of production, the price level varies inversely with the productive efficiency other things being the same, and the total stock of active money increases with the total money income so that the income-velocity remains the same. We have also an explanation how forced levies and anti-levies of wage-goods result, if the bank rate of interest differs from the proper rate—which is the rate which maintains the standard monetary system.

The concluding part investigates the effect on the aggregate volume of unemployment of fluctuations of real demand for labour in different centres of industry, of wage-policy and of other factors. According to the author's view it is the state of real demand for labour which is the essential determinant of the percentage of unemployment, and the real wage-rate stipulated for by work-people in normal times is always adjusted to the average state of real demand for labour. Hence he is not inclined to attribute much significance on the high correlation between real wage-rate and unemployment, obtained in recent statistical studies. Such significance can only result, according to the author, if changes in the real wage-rate are independent of changes in the real demand for labour. In fact, however, a shift in the demand for labour may produce shifts either in the same sense or in the opposite sense in the real wage-rate.

In spite of the handicap of the lack of statistical data for testing or justifying the results obtained, the increased insight obtained from the book into the economic mechanism of unemployment, and the number of definite results are considerable. A combined organisation of all governments and trade organisations to gather extensive and reliable economic statistics, somewhat on the lines of recent work in America, would result in a few years' time in untold progress to economic science.

The large number of mathematical formulæ in the book, seems to have occasioned many printer's errors and author's corrections; over and above those listed in the Errata, there are misprints on pages 58 and 136. The student may probably feel that some places in the book are not sufficiently explanatory. The theory of

interest dealt with in the footnote on p. 179 may with advantage be inserted into the argument at the bottom of p. 83. The treatment of the standard monetary system and the money factor could in places easily bear further explanation, without much danger of interrupting the main argument.

R. VAIDYANATHASWAMY.

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ANALYTICAL GEOMETRY. By Vincent C. Poor, Ph.D. (Chapman & Hall Ltd., London. 1934. Pp. 244.) Price 13*s.* 6*d.* net.

This new text-book, in splendid get-up, is very ably written for the first year course in colleges and presents some unusual features. It is conceived on broad lines, and without going into detailed developments in any topic is able to keep the emphasis throughout on the general apparatus of ideas and procedure, characteristic of the subject. The ground covered is wide. In addition to conics (general equations of the 2nd degree, standard forms of the parabola, ellipse and hyperbola asymptotes, diameters, pole and polar) and transformation of co-ordinates, we have an elementary chapter on the tracing of higher plane curves and the fitting of polynomial curves to statistical data; and the final quarter of the book is devoted to Solid Geometry and proceeds as far as is necessary for a general notion of curves and surfaces including the different types of ruled and non-ruled quadrics. One appreciates the Introduction of elementary plane and solid geometry at the same stage to the pupil, without making the usual artificial distinction between them. It is quite likely that certain portions, for example the ruled and non-ruled quadrics, may prove too difficult for the first year of the University (which would correspond to our Senior Intermediate), but the general tone is elementary and one does get the impression that the major part of the book, on the lines on which it is written, would be a feasible course for the first year. This of course does not apply to the Indian Universities which have sought safety by completely mechanising their education and their curricula and afford little scope to the original-minded teacher for initiative or experimentation in teaching.

It does not strike one in reading the book that the vector concept is used to any special extent or in unusual or novel situations. It is therefore surprising to find that the author claims in the introduction the use of the vector idea as the justification for this new book. Apart from the fact that the book offers several other novel features for consideration, this particular claim is misleading and tends to raise false expectations. By 'vector geometry' one would understand a method in which, even though the proofs may be analytic, the outlook and the theorems are all synthetic, that is, are stated in terms of the geometrical elements (point, line, vector, etc.) *as such* without breaking them up into co-ordinates. It is problematic whether such a synthetic viewpoint can be introduced in a first course in analytic geometry with any success.

In certain cases, the author's interference with convention has not turned out happily. What for instances is the advantage in changing the classical nomenclature on 'one-sheeted' and 'two-sheeted' hyperboloids into 'un-parted' and 'bi-parted'? What again is the justification for writing the general equation of the second degree without binomial co-efficients? The writer who would do so has definitely no feeling for the theory of forms, which either overtly or covertly lies behind the geometry of plane algebraic curves. Again on p. 192, a cylinder is defined to be 'a surface generated by a line moving parallel to itself and tangent to a fixed curve'. The meaning intended for 'tangent' here is not merely unconventional but unscientific. Lastly, the author while expatiating upon the fact that a line through the intersection of two given lines L, L′ is of the form $L+kL'$ has not thought it necessary to mention the symmetrical determinantal condition for the concurrency of three lines! The only explanation of the strange fact that I can think of is that the intellectual bias of the author is directed away from the intuitions and values which derive from the theory of forms.

Another curious point is that while the author has throughout stressed the idea of 'locus', he has omitted to mention the fact that the circle or conic $f(x, y)=0$ has two sides, the expression $f(x, y)$ taking different signs of these sides. This fundamental topological idea is not only important in itself (*e.g.*, in the question whether a given point is within or without a given circle or ellipse) but actually helps the learner to get a better grip on the difficult idea of 'locus'.

Lastly, there are two suggestions which I would like to make both to the present author and to writers of Introductory text-

books on Analytical Geometry. These, if followed, would in my opinion help the learner considerably and remove a certain fogginess from the subject. These are :—

1. To distinguish sharply the two meanings with which the word 'angle' occurs in analytical geometry, and to relate the two meanings to the concept of directed line. Namely, there are certain situations (*e.g.*, the slope angle of a line, the angle between two lines) in which the measure of the angle is relevant only mod $\pi$ and certain other situations in which it is relevant mod $2\pi$ (*e.g.*, vectorial angle in polar co-ordinates, the angle $\alpha$ in $x \cos \alpha + y \sin \alpha = p$, $p$ being positive).

(2) Whenever a square root occurs in an elementary formula, to explain why it occurs and why it would not but occur.

R. VAIDYANATHASWAMY.

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SOLID MENSURATION. By Willis F. Kern. and James R. Bland. (Chapman & Hall, London. 1934. Pp. 73.) Price 7*s.* 6*d.* net.

This is a finely printed handy book on Solid Mensuration containing a list of fundamental formulæ and proofs of the more difficult theorems. The numerous illustrations and diagrams and the historical information about the various solids are attractive features. The real value of the book lies, however, in its large and unique collection of examples which are all of a practical nature and of a kind to interest the pupil. The authors intend this book for regular use in the secondary school and for the use of the backward student in the College.

It is notorious that the standard in Solid Geometry in the secondary education of this country is very low. The higher mental functions of the genus 'man' depend entirely on the two forms of his thought, the visual and the auditory. The latter is of course very important and is related closely to man in his social relations; as the factor which is responsible for the preservation and transmission of conscious race memory it is fully represented in our education. But it is the former which is at the root of all higher imagination and creative thought, and it receives considerably less than its due share of attention in our education. Discipline in Solid Geometry and Mensuration fairly early in the secondary stage is the only feasible method in general education for stimulating the potentialities of visual thought.

R. VAIDYANATHASWAMY.

CARRES MAGIQUES AU DEGREE N. By E. Cazalas. (Hermann & Co., Paris. Pp. 191.) 40 francs.

This book by Cazalas expounds the Tarry-method of constructing magic squares. In a note by Gaston Tarry presented by Henri Poincare to the Paris Academy of Sciences, he announced that it was always possible to construct a magic square of side $p^n$, which is magic up to degree $n$ provided the least prime factor of $p$ be large enough; *i.e.*, it is possible to fill up the square with the numbers from 0 to $p^{2n-1}$ in such a way that the sum of $r$th powers of numbers in any column or row is the same for all integral $r \leqslant n$. It is really remarkable that the method of construction depended only upon the solution of certain linear congruences. Unfortunately, Tarry did not publish his method although he gave numerous examples of such squares. In the present treatise the author has given us a method of solving the general Tarry-problem by making use of the numeral series of Tarry. The book merits not only the attention of those engaged in mathematical recreations, but also of mathematicians as well.

The book is divided into seven chapters. It also contains a historical review of the subject of magic squares and at the end we find a complete bibliography. The first chapter defines the numeral series of Tarry and various notions such as panmagic, diagonal magic, etc. It also gives the method of construction of magic squares when the number of houses in each column or row is a prime number. In the second chapter we come across the construction of magic squares of side $p^2$ where $p$ is a prime number which is also bimagic, *i.e.*, the sum of the squares of the numbers of elements in each row or column is the same. The third chapter deals with squares which are trimagic. In both these chapters, the way of construction of magic squares with other magic properties is also expounded. Numerous examples are also given. The fourth chapter deals with squares of side $p^n$ which are magic of various degrees. Magic squares with some special magic properties are dealt with in Chapter V.

Chapter VI deals with squares of side $m$, where $m$ is composite. In Chapter VII the mixed Tarry series are used for the construction of magic squares. Generalisation to magic hypercubes in various dimensions are also given. After the bibliography

a square of 64 sides which is magic upto degree 3 is given.

One commendable feature about the book is that it does not presuppose any mathematical knowledge on the part of the reader. The lovers of magic squares owe a deep debt of gratitude to the author for his beautiful treatise on the subject.

K. V. I.

ETUDE DES FONCTIONES SONSHARMONIQUES AN VOISINAGE D'UN POINT. By Marcel Brelot. (Hermann & Co., Paris. Pp. 55.) 14 francs.

Sub-harmonic functions can be looked upon as a generalisation of potential functions or as an extension of the notion of convexity to functions of two variables. Not only are they interesting in themselves but they are also useful in some problems in potential theory such as the existence of a solution of certain allied differential equations, and in the discussion of the behaviour of a potential function in the neighbourhood of its boundary. The development of the subject owes much to the work of F. Riesz and Montel. This monograph, third in the series of Memoirs published in honour of the mathematician Jacques Herbrand who unfortunately died at the early age of 23 after contributing very interesting papers on mathematical philosophy and algebraic numbers, is written in a very lucid and excellent manner.

The work is divided into three chapters. The first chapter deals with the general properties of sub-harmonic functions and their intimate connection with harmonic functions. The second chapter deals with properties of a function sub-harmonic in the neighbourhood of a point but not sub-harmonic at that point itself. After defining the maximum modulus, some properties analogous to the properties of analytic functions are also enunciated and proved. The theorem about the continuation of the sub-harmonic function to the point in case it is bounded, is very interesting and it is a generalisation of Riemann's theorem in analytic functions. At the end of the chapter, three examples of sub-harmonic functions are given behaving at the point in very singular ways. Some results are also generalised to the case of functions which are sub-harmonic in the neighbourhood of a closed set of points of measure zero. The third chapter is devoted to applications. Some results in connection with Wienner's generalisation of Dirichlet's problem and the existence and properties of the solutions of certain differential equations allied to Laplace's equation are discussed. For simplicity, the author has confined himself to two dimensions for, the generalisation of the results to any number of dimensions is direct and very simple.

K. V. I.

ELEMENTARY PRACTICAL MATHEMATICS. By J. W. Chaithness, B.A., B.SC. (Chambers Ltd., Edinburgh. Pp. 318.) Price 3*s*.

Like general science, Practical Mathematics is looming large now-a-days in the curricula of studies for Secondary Schools. The student desirous of going to a technical school, after he finishes his school certificate, need not know all the aspects of Mathematics, which have a purely theoretical value. What the student of technical studies requires to know is, that aspect of mathematics, which will be of direct interest to him in his technical studies, be it Engineering, Building trades, or a higher branch of specialised science. Books dealing with this aspect of Mathematics are generally welcome.

The author is the Principal of a Municipal Technical School in England, and is thus specially qualified to write books on Practical Mathematics. The student of the Technical School should know enough Mathematics to enable him to get his workshop or laboratory results, with ease and accuracy. He need not know for instance the proof of a certain principle but he needs to know its application. What is attempted in the present work is the exposition of these principles and methods which are of general application to all technological studies. This book is intended to cover the course prescribed for Central Schools and Preparatory Technical Schools of England. It is expected that the course dealt with in this book will prove to be of great use and will serve as a foundation on which the more advanced Mathematics of the Engineer or the Physicist may be built. In addition to the useful portions in Arithmetic, Algebra and Geometry, a chapter on graphs and applications of calculus to approximations, areas and volumes, is given, which will be highly useful to the student for whom the book is specially meant.

The vocational and technical schools now developing in India will find this book immensely useful.

The printing and get-up of the book are excellent.

B. V. SASTRY.

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THE LABORATORY WORKSHOP. By E. H. Duckworth and R. Harries. (Published by G. Bell & Sons, Ltd., pp. xi+246.) Price 10*s*.

It is now generally recognised that a certain amount of workshop experience or at least a little deftness in the use of the more common tools is a necessary adjustment to one's education. The post-graduate student, the science teacher, and all those who take up science as a profession will in their experience meet with diverse problems wherein a little familiarity with tools will prove to be of immense value. This means not only a saving of time but also a certain amount of stimulus to new ideas, and designs, of apparatus with which they may be concerned. This little book is written to help one acquire this knowledge.

The book opens with a description of practically all the tools that one is likely to handle in the workshop. There are some valuable hints as regards the choice of tools and other materials to equip a small laboratory workshop. The chapter on the properties of various materials that are ordinarily used in the construction of apparatus is very useful. The common operations, such as, cutting, filing, chiseling, drilling and bending, are fairly well explained and should certainly be valuable to the beginner. The operations involved to cut screw threads with the help of taps and dies are really very simple. But it is a common experience to see the beginner take up to this with a certain amount of nervousness usually ending in the most disastrous results, as evidenced by the number of broken taps and dies that fill what was once a complete set of screw plates. In view of this the authors have written a fairly elaborate chapter on screw cutting which will make one realize how simple it is to do the job if one only remembers the important hints detailed there. Another chapter is devoted to the very useful art of soldering. One often notices in the workshop, young men who can hardly resist the temptation of wistfully watching with admiration and envy the expert, who handles it with such ease and confidence. The hints and tips on soldering will go a long way at least, to give confidence, if not make an expert of a beginner. The final chapter giving examples of construction of various scientific apparatus is helpful in suggesting further work on similar lines.

The authors' intention of stimulating the dormant talents of "invention" and "resourcefulness" in young men, by omitting to mention anything that has to do with lathes is rather questionable, or at least true only to a very limited extent. Really there is no end to the variety of ingenious uses a lathe can be put to, and one is rather inclined to think that the use of a lathe will prompt young men to construct exceedingly ingenious apparatus, sometimes of far-reaching consequences, which would not otherwise be possible. The practically-minded man is surely deprived of what is perhaps the most interesting part of his experience. The inclusion of a couple of chapters on lathes and simple turning would certainly have been most salutary to the interests of ingenious young men, and made the field of usefulness of this book more extensive. But still within the limit set upon by the authors the book does serve a useful purpose, in introducing the beginner to the workshop, and providing useful hints to those constantly in need of the use of one, and in providing an excellent book of reference for general use.

C. C.

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ALTERNATING CURRENTS. By L. T. Agger. (Macmillan & Co., Ltd., London, 1934.) Price 5*s*.

This book is divided into 15 chapters most of which are devoted to the fundamentals of alternating currents. The opening chapter considers the production of alternating voltage and current, their effective values and meaning of power in a circuit containing resistance only. The following 8 chapters deal with the meaning and value of inductance and capacitance and the behaviour of series and parallel circuits containing combinations of resistance, inductance and capacitance. Chapters 10 and 11 deal respectively with the properties of polyphase currents and power in polyphase circuits. Although the ground covered in these 11 chapters is the same as in the opening chapters of most text-books on alternating current engineering, the subject is treated with clearness and simplicity which cannot easily be surpassed. Chapters 12-14 deal with the elements of transformer, alternator and induction motor and the last chapter with measuring instruments.

The author has made use of a large number of diagrams, curves and examples in the text to give the reader an unmistakable idea of the points dealt with and exercises are given at the end of each chapter. This is the simplest book that the writer has seen and it is difficult to imagine that anybody going through it can fail to get a correct conception of the most important fundamentals of alternating currents.

J. J. R.

THE ELECTRONIC STRUCTURE AND PROPERTIES OF MATTER. By C. H. Douglas Clerk. (Chapman & Hall, Ltd., London.) Pp. xxv + 373.) Price 21*s*. net.

With the present rapid rate at which atomic and molecular theories are progressing, it is increasingly difficult to keep in touch with developments not in one's immediate sphere. Consequently any attempt made at presenting in a lucid and cogent manner the ideas developed in the several branches of the same science and particularly their inter-relations with each other, should be welcome not only as a food for thought, but also as a stimulant for further progress in the particular branch one is specialising in. Such a task has been undertaken by Mr. Clark with a zeal that has resulted for the present in three volumes forming the commencement of a series in "A Comprehensive Treatise on Atomic and Molecular Structure". The book under review is the first in the series, and is divided into two parts the first of which deals with the atomic and electronic quantum numbers, the inward nature of the periodicity of elements, the modifications to the original Bohr's concept of quantum numbers, the theory of inner building in the transition and rare earth elements and its bearing on the diverse valency possibilities, and ends with a very general review of the older electronic and the newer quantum and wave mechanical interpretations of different types of atomic linkages. Full details are not generally gone into but either postponed to later volumes or referred to original papers.

The second part deals in greater detail, though still in a rather summarising manner with the various physical properties of matter and their relation to the electronic structure. The subjects treated are in the order, melting and boiling points, atomic and molecular volumes, atomic and ionic radii, electrical conductivities of elements and crystals and related photoelectric effects, the conductivity of melted compounds and its bearing on several factors such as valency and size of the ions, the phenomenon of super conductivity and theories of super conducting state, magnetic susceptibility, additivity relationships, dia-para- and ferro- magnetism, atomic magnetic moments, cohesive force, surface tension, coefficient of expansion, and lastly entropy and its significance.

It is not possible to indicate any particular aspects of the subject that have been neglected, as in the author's scheme the three projected volumes form one unit, and frequent cross references are given to the second and third volumes which are "in preparation". It can, however, be said that the author has succeeded in giving a faithful running account of the trend of modern ideas regarding the properties of matter, and when any further details are wanted they can be either found in the latter volumes or in the references to the original and other "summarising" papers listed at the end of each chapter.

The practice of collecting together at the end of each chapter all the references is not always commendable, but seems to be well suited for the kind of book under review, where a group of papers on the same topic are given together with the necessary full titles of the papers. However, the peculiar list of abbreviations adopted by the author for the names of the journals seems quite uncalled for; unfortunately there is no standard practice adopted in this respect in the scientific literature, but still to some degree the abbreviations used conform to a certain type, and the aim should be to try and standardise the abbreviations in use rather than invent unnecessarily new ones such as 'C' for Transactions of the Royal Society of Canada, 'C. R.' for Chemical Reviews, 'F' for Transactions of the Faraday Society, and 'P. M.' for Philosophical Magazine, and others such as 'C. L.' or 'R. M. P.' The author himself has used in p. 86, for reference No. 27, the abbreviation 'T. F. S.' which is not to be found in the list given in p. xxiii, and which is obviously a mistake for 'F' the Transactions of the Faraday Society.

There are a few printing mistakes in the text such as those in p. 22, l. 1, p. 226, l.19 or p. 236, l. 4, and others in the equations 9*b* in p. 331, and those given in the top of p. 335.

The publishers have done their task well and the printing and binding are up to their well-known standards.

M. A. G.

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THE FUNDAMENTALS OF CHEMICAL THERMODYNAMICS. PART II. THERMODYNAMICAL FUNCTIONS AND THEIR APPLICATIONS. By J. A. V. Butler, D.SC., Lecturer in Chemistry in the University of Edinborough. 271 pages. Price 8*s*. 6*d*.

This little book is the second part of the author's 'Fundamentals'. Although the more elementary calculation of maximum work and simpler applications of first and second laws of thermodynamics have been treated in Part I, the subject has been discussed in fuller detail and from more advanced point of view using thermodynamical functions in the classical manner so that the present volume is tolerably complete by itself.

The system of symbols used is that of Lewis and Randall the corresponding notations of Gibbs and German workers being also given to assist when referring to original papers. Unfortunately, the author has given the standard values for energy and entropy referred to 25° as against the German practice of calculating these to absolute zero.

The third law has been developed with due regard to the methods of Nernst and Lewis and mention is made of the American work on supercooled liquids and a brief discussion on the chemical constants of simpler gases.

The main feature of this book is the comprehensive discussion of the properties of solutions especially of electrolytes which has apparently salted out, the more important applications of thermodynamics to equilibria in organic reactions and reactions at high temperature. This partiality is obviously due to author's own contributions to the subject of solutions which he has treated in a lucid, thorough and up-to-date manner. This is very welcome especially in view of the long time having elapsed since the appearance of the well-known work of Lewis and Randall whose clear and pleasant presentation of the subject remains unsurpassed.

There is a unique chapter on the thermodynamics of surfaces. The activity concept is applied to adsorption from solutions. The last chapter gives a concise discussion on the Phase Rule and the geometric methods of Gibbs as applied to the stability of binary and ternary systems.

There are up-to-date references to papers including author's own and an index at the end. The paper, printing and get-up is good and price moderate. The students of physical chemistry will find this book a welcome help.

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LA NOTION DE CORPUSCLES ET D'ATOMES. By Prof. Langevin. (Hermann & Co., Paris.)

With the ever-increasing isotopes, the neutron and the positron, to say nothing of the now old electron, proton and photon, our knowledge of the constitution of matter is extending both intensively and extensively at such a rapid pace that it is quite a job for anybody to keep in view, if not in touch, with modern progress in all its details. It is hence a signal service which Prof. Langevin has done in his address on 'La Notion de Corpuscles et d'atomes' published by Hermann et cie, Paris, as Report No. 132 in the well-known series "Actualites Scientifiques et industrielles" 1934 (price 12 fr.). Prof. Langevin has started at the very beginning so that even a Rip Van Winkle in science cannot complain of any links missing in the chain of progress. He begins with the Democritian doctrine of the divisibility of matter and the existence of ultimate particles and pays a tribute to chemists for having followed up the idea and placed it on a quantitative basis in their elucidation of molecular and atomic weights. Both these quantities are, however, only comparative values and it is due to the more exact sister science that an accurate knowledge of Avogadro's number was possible and thence an absolute value for those quantities. The next step in the progress came with the advent of the cathode tube in the last quarter of the last century and with it the idea of corpuscles.

A brief but coherent account is given of J. J. Thomson's experiments for establishing the electron as a definite physical entity, of Lorentz's theoretical conception of an electrified granular structure of matter for explaining certain optical phenomena on the electromagnetic theory and Wilson's cloud chamber methods of, as it were, visualising the electron. He explains how photographs taken by the cloud chamber methods were used to verify the photoelectric law on the equivalence of energy exchange between matter and radiation, a verification which led on to the conception

of a structure of radiation, a ground already prepared by Planck, Einstein and others in their discussions on the emission and absorption of radiation by matter, the spectral character of blackbody radiation and the inertia of energy. Mention is also made of Compton effect as experimentally confirming the corpuscular conception of both matter and radiation. Rutherford's experiments on radioactivity and the disintegration of matter leading on to the conception of the proton and the nuclear atom model are described with suitable photographs taken by the cloud chamber method. Finally, the experiments of Bothe and Becker and the discussions thereon of Chadwick and others leading to the discovery of the neutron and the positron are explained in an interesting manner. Thus in a brief but very illuminating review Prof. Langevin has brought out our modern corpuscular conception of the universe as consisting of electrons, protons, neutrons and positrons on the material side and photons on the energy side, the two sides, however, being mutually convertible.

Having thus summarised the present experimental knowledge on the structure of matter, Prof. Langevin proceeds to review the situation from the theoretical viewpoint. After a brief reference to the classical electromagnetic theory and its limitations when applied to the dynamic atom, the introduction of Planck's quantum conditions in the mechanics of the Rutherford-Bohr atom model, Prof. Sommerfeld's exhaustive and successful treatment of the hydrogen atom and its limitations when applied to atoms with several electrons, mention is just made of the development on the one hand of matrix mechanics by Heisenberg, Born and Jordon and on the other hand of wave mechanics by Louis de Broglie, Schrodinger and Dirac. Prof. Langevin gives a clear though very brief account of the train of thought that led on to the wave conception of matter, mentioning the experiments of Davisson and Germer and G. P. Thomson.

This brings him on to the greatest pitfall of all in modern science, *viz.*, the dual conception of the electron, corpuscular at times and undulatory at other times. The dual nature of the electron has been the two horns of a dilemma between which, not being able to choose one and exclude the other, scientists have been trying to strike a compromise. Bohr calls the two aspects complementary and has enunciated his principle of complementarity. Born, in trying to reconcile the two ideas, introduces a statistical character in the discussion which, however, destroys the objectivity of electrons, protons and photons. Heisenberg has, at this stage, introduced his Principle of Indeterminacy according to which it is not possible to know at once the position and momentum of an electron.

Prof. Langevin taking up the method of Born suggests a return to a statistical treatment. Knowing that the Boltzmann-Gibbs statistics has failed to agree with experiment, he suggests the applications of the Bose-Einstein and the Pauli-Fermi statistics with the Pauli's exclusion principle thrown in when dealing with charges. Mention is made of the successful application of this method by Bose, Debye, Jeans and others.

Prof. Langevin concludes with a moral disquisition on the effect of long habit on the anthropomorphic tendency of our minds in finding an object more easy to deal with than an idea. He makes a very interesting observation that the original conception of an object should have been as abstract as our present conception of an idea and just as in course of time we have familiarised ourselves with dealing with objects, we should begin now to deal in the abstract with conceptions and bequeath this habit as a convenient heredity to our posterity.

P. S. S.

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THE HARDNESS OF METALS AND ITS MEASUREMENT. By Hugh O'Neill, D.SC., M.Met. (Chapman & Hall. 1934. Pp. xiv + 292.)

This is a most valuable addition to the excellent series of books on metallography published by Chapman & Hall. Its scope is much wider than its precise title would appear to indicate. The theories underlining various concepts of hardness are very fully studied, physical, chemical and mathematical principles being exhaustively explained. The Static Ball Test is fully studied with particular reference to Brinell's test. The author devotes three chapters to consideration of hardness in relation to internal structures of metals. Of these chapters those on the crystalline nature of metals and alloying and heat-treatment are worthy of special commendation. The chapter on practical aspects of testing hardness is one that should be read by all engineers using hardness testing machines, especially with reference to the method of

preparation of a sample. The author's style is such as to make the book interesting and always readable even in the more mathematical portions. It is profusely illustrated and contains many beautifully reproduced photographs. A copious bibliography containing over 400 references adds to the value of this book.

CHARLES FORRESTER.

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A TEXT-BOOK OF GENERAL BOTANY FOR COLLEGES AND UNIVERSITIES. By Richard M. Holman and Wilfred W. Robbins. Third Edition. (John Wiley & Sons. Inc. New York. 1934.) Price 25*s*.

As the authors have stated in the preface, the essential qualities of a good text-book have been recognised and kept up throughout the pages of this book. The arrangement of the subject-matter and its treatment deserve special appreciation. The first part of the book comprising about 300 pages not only introduces the reader to the realm of the biological science, but also takes him through the detailed mechanism and functions of the Flowering plants in particular. Seven chapters of this part have been devoted to the study of the chief parts of the plant body. The chapter on "The Stem" has been treated in a masterly way. The other parts of the plant body like Root, Leaf, Flower, Fruit and Seed have been treated with equal justification. The authors appear to be partial to anatomy rather than physiology. The chapter on the Relation of the Plant to its environment, really gives a true picture of the activities of the plant and the position of the plant in the organic world not as an isolated but as an interdependent unit of a large fabric.

The second part of the book is devoted to the study of the representative members of the other groups of plant kingdom, like Algæ, Fungi, Liverworts, Mosses, Ferns and Seed-plants. Full justice has been done to every one of these groups in their treatment and the beginner finds it very easy to follow the life-history of the plants, specially along the straight road with mile-stones and furlong-stones, as illustrated by the summary of the principal features in the life-history of wheat. The chapter on Evolution and Heredity gives the reader in a nutshell all the principal ideas and their associated views included in the above subjects, and has been presented in a graphic way. Even the latest ideas have been incorporated. The past history of the plants as evidenced by the Fossils has been dealt with briefly, giving a true picture of the vegetation of the land in those bygone days and the importance of the study of such vegetation in solving the problems of Evolution.

The book has been nicely got up and has been profusely illustrated. The drawings and sketches are scientifically accurate and their illustrative value has been enhanced by a large number of photo-micrographs that appear throughout the book. The fact that during these ten years, the book has gone through three editions, is a proof positive of its usefulness to the students and the teachers as well.

L. N. RAO.

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GROUNDWORK OF BIOPHYSICS. By G. M. Wishart, B.SC., M.D. (George Bell & Sons, Ltd., London. 1931. Pp. vii+344.)

A study of the recent developments in Physiology or Biochemistry will show that progress in the fundamental conceptions of life processes can best be assured by a liberal application of the technique of the physicist. This is being increasingly recognised and the contributions of S. P. L. Sorensen, L. Michaelis, J. Loeb, W. M. Bayliss and T. B. Robertson only serve to emphasise this. To-day Physical Chemistry and Biophysics are included in the curricula of studies in Physiology and Biochemistry.

The book under review "is an attempt to aid the student by bringing within small compass those aspects of physical chemistry and physics which he will find most necessary in his physiological studies." One cannot help feeling that he is reading an elementary text-book of physical chemistry as he reads through the book. In the later half of the book an attempt is made to deal with selected sections of physiology such as *vision* and *hearing* which demand familiarity with such chapters in Physics as *optics* and *sound*. As a text-book for the University student, the publication will meet with his requirements. The treatment is elementary but clear and the book can be recommended to those who require to be introduced into the subject of Biophysics.

There are few printer's mistakes and the publishers deserve to be congratulated for the neat get-up.

# SUPPLEMENT TO "CURRENT SCIENCE".

## The British Association for the Advancement of Science, Aberdeen, 1934.

### Presidential Address—The New World-Picture of Modern Physics.

By Sir James Jeans.

SIR JAMES JEANS delivered a highly thought-provoking address at the Aberdeen Meeting of the British Association for the Advancement of Science, taking as his theme "The New World-Picture of Modern Physics". He first commented on the happy auspices under which they had assembled, the Scottish meetings having been traditionally successful, but there was the early death of Sir William Hardy which he deplored and which he said had cast a shadow in all their minds. After paying an eloquent tribute to the excellent qualities of the departed, the lecturer proceeded to the subject of his address. In the fifty years' interval between the time when one theoretical physicist—Lord Rayleigh—had occupied the chair and the present occasion when again the presidentship had fallen to a theoretical physicist, the science of physics had changed and developed beyond recognition. The old explanations, based on an attempt to understand nature by means of familiar models, had failed to cover the new facts and the mathematical formulae which represented the facts well showed that the explanation was like a parable. The modern difficulties regarding the nature of the world were all due to the mistake of taking these parables to represent the actual truth. It is a natural tendency for man to prefer concrete facts to abstract principles, but since all measurement implies the comparison of one quantity with another of similar nature, we could become cognizant only of the relations which we ourselves discovered, but the essential nature of the quantity compared would be beyond comprehension. Thus all our knowledge about observables would be numerical or mathematical in content while whatever we thought we knew about unobservables would be pure assumption. That was the reason why the attempts of the nineteenth century physicists to explain the wave-nature of light by trying to picture the properties of the ether led to false conclusions. It was only the imagery that led people to expect a positive result in the Michelson-Morley experiment. The null-result showed the error of taking this imagery to be representative of external nature. Since the general theory of relativity showed that the space-time continuum could be twisted and warped as much as we please, even this continuum could not be itself part of Nature. Since all our knowledge comes through our senses it was but natural to postulate the existence of "matter" as a starting point for the effects which reached our senses, but this "matter" is as unobservable as the ether. For example, earthquake waves affect our houses by travelling along the surface of the ground but it is not right to assume that they originate in the surface. So also space and time or the space-time continuum might be the means through which our senses are affected but that would not prove that they were part of Nature.

Theoretical physics is no longer concerned to study the Newtonian Universe which it once believed to exist in its own right in space and time. It merely sets before itself the modest task of reducing to law and order the impressions that the universe makes on our senses. Its task resembles that of the map-maker who can represent different aspects of a region of the earth's surface by means of different projections, but who does not make the mistake of taking the map to be the earth. Newtonian physics was like the map of a small region in that it represented the motions of medium-sized objects correctly but failed to represent the infinitely great and the infinitely small. The new physics provided a map of the whole universe but some properties of the small map, such as representation in time and space and the old determinism, could no longer be found in the larger one. Just as the map-maker requires different kinds of maps to represent different aspects of the earth, theoretical physics provides two pictures—the particle picture and the wave picture. Bohr's theory of the hydrogen atom showed that the particle picture was inconsistent with Newtonian determinism—there was no way of predicting which particular atom would suddenly change in energy and radiate, as Einstein pointed out. But even this picture failed to represent the whole of experience. Then came the wave picture; this gives a wave in ordinary space only for a crowd of electrons moving as in an electric current, but the picture extends to more dimensions when other phenomena have to be represented. It has not been possible to combine the particle and the wave picture into one better representation as we can combine the different kinds of maps into a single globe. We cannot say whether it is impossible to arrive at such a unified picture or it is some ingrained habit of thought that is preventing us from realising it.

In spite of this lack of a unified representation of the Universe, the relation between the particle and the wave picture is definitely known. The more stormy the waves at any point in the wave picture the more likely we are to find a particle at that point in the particle picture. Yet if the particles existed as points and the waves depicted the chances of their existing at different points of space—as Maxwell's law does for the molecules of a gas—then the gas would emit a continuous spectrum instead of the line spectrum that is actually observed. Thus we had better put our statement in the form that the electron is not a point-particle, but that if we insist on picturing it as such, then the waves

indicate the relative proprieties of picturing it as existing at the different points of space. But propriety relative to what? The answer is—relative to our own knowledge. If we know nothing about an electron except that it exists, all places are equally likely for it, so that its waves are uniformly spread throughout the whole of space. By experiment after experiment we can restrict the extent of its waves, but we can never reduce them to a point or indeed below a certain minimum; the coarse-grainedness of our probes prevents that. There is always a finite region of waves left. And the waves which are left depict our knowledge precisely and exactly; we may say that they are waves of knowledge—or perhaps even better still waves of imperfections of knowledge—of the position of the electron.

But there is one surprising situation here; the waves are supposed not to be a picture of our knowledge of Nature, but of Nature itself. That would mean that Nature was in our minds and not external to the observer. The Nature we study is not the object of our perceptions but is made up of those perceptions themselves. We are forced to this conclusion because whenever the particle picture comes into conflict with the wave picture the wave-picture has been shown by observation to be the correct one. Such is the case in G. P. Thomson's experiments on the diffraction of electrons, or in the phenomena of the leakage of particles through a potential barrier. When we retain the particle picture and try to explain what peculiarity allows some out of a number of similar particles to get through the barrier, we will have to answer that it is a question of chance or Fate. For example, when we picture light as a swarm of photons, it is difficult to see why a certain number of them pass through a semitransparent obstacle, and which individual photons are thus singled out. Thus the behaviour of any individual photon—whether it will be reflected or transmitted—is indeterminate. But in the wave picture the question of the individual photon does not arise at all and hence the process is quite deterministic. Similarly, the principle of Pauli shows that an electric current should not be thought of as a swarm of identifiable electric particles. If two electrons collide and go off in two different directions we have no right to say that the latter electrons are the same as those that collided. The determinism which appears in the new physics is one of waves and so, in the last resort, of knowledge. Where we are not ourselves concerned we can say that event follows event; where we are concerned, only that knowledge follows knowledge. And even this knowledge is one only of probabilities and not of certainties. So it is impossible to decide whether our minds can change what is happening in reality or whether they only make it look different. The problem of free-will will hence remain a debatable question which cannot receive a definite answer. We cannot say that materialism is dead, but it has to be so refined that it may be doubted whether it may still be called materialism. The objective and material universe of the Victorian scientist is shown to consist of little more than constructs of our own minds. But the problem arises—why should all our minds construct the same nature? Sir James Jeans answers that it is probably because all our minds are parts of one whole, our individualism being merged in the stream of life when we cease to view ourselves in space and time.

Sir James then proceeded to show how the complaint that all our modern woes of unemployment and competition were due to the indiscriminate advance of science was not entirely well founded. He pointed out that the tragedy lay not in man's control over Nature but in the absence of moral control over himself. The remedy lies not in giving up science, but in extending its methods to other walks of life, by means of the science of psychology for instance. If economic depression and unemployment arise from rationalisation and scientific efficiency, science also provides new avenues of employment by creating new industries. It is certainly safer to solve the problem this way than to scrap science and sit patiently waiting for the catastrophe due to increase of population to come to us in the form of war, famine and disease. Nor is it right to decry pure science, for no investigator knows beforehand what discovery he is going to make and in what way it can be applied. If pure science is stifled, applied science will be nipped in the bud. So Sir James concludes by exhorting all thinking men and women to ponder and decide whether it is better to risk the fate of that over-ambitious scientist Icarus, rather than resign ourselves without an effort to the fate which has befallen the bees and ants.

## Mathematical and Physical Sciences.

*President*: PROF. H. M. MACDONALD, O.B.E., LL.D., F.R.S.

### "THEORIES OF LIGHT."

THE early theories of light started on the basis of a comparison with the way in which our other senses are affected. One view advocated by Empedocles took a hint from the sense of smell and imagined light to be some sort of emanation of particles from the luminous body; the other put forward by Aristotle compared light with sound and regarded it as undulations generated by the source. These views were revived in a more definite and quantitative form by Newton and Huyghens respectively. The ease with which the corpuscular theory accounted for rectilinear propagation and Newton's authority conspired to bring this theory into general acceptance until the beginning of the nineteenth century when Young showed how the wave-theory could be made to yield an explanation for the formation of shadows. The phenomena of interference, diffraction and particularly of polarisation were seized upon by Fresnel to establish the wave-theory on a secure foundation. Fresnel and Young were able to show that the light disturbance was propagated as transverse waves and Fresnel succeeded in explaining the optical properties of crystalline media and also the distribution of intensity and the polarisation of the reflected and refracted beams—a problem which had only found an *ad hoc* qualitative explanation in Newton's hypothesis of fits of easy reflection and easy transmission.

Now began a series of researches with the object of deducing the properties of the light-waves analytically from hypotheses as to the nature of the medium—the luminiferous æther—which transmitted the luminous disturbance. Cauchy

was the first to develop such a theory; later on Green discussed the problem from a more general viewpoint, only assuming that the mutual action of portions of the elastic medium were such that they possessed a work function. He showed that this function involved only two constants in the case of isotropic homogeneous bodies and that the velocity of propagation of normal waves must be infinite if the medium is stable. The difference between two isotropic homogeneous media is assumed to be a difference in their densities and formulæ are obtained agreeing with those of Fresnel accurately in the case of waves polarised in the plane of incidence, and approximately in the case of waves polarised perpendicular to this plane. Green also assumed that the light vector was perpendicular to the plane of polarisation in agreement with Fresnel while Cauchy had assumed it to be in that plane. In these investigations Green used a general dynamical method due to Lagrange and extending it to the case of crystalline media he showed that in order to arrive at Fresnel's results one had to assume extraneous forces. Cauchy also came to the same conclusion that an elastic solid medium which is self-contained and free from external constraints cannot account for the observed facts. Various modifications of this theory were advanced, for example, by Lord Kelvin, but the final upshot of it all was to show that the elastic solid theory could not give Fresnel's results without further hypotheses and that agreement with Fresnel's results meant agreement with nature.

The next important advance was due to Faraday who showed that the plane of polarisation is rotated by a magnetic field. Faraday's views about light show his keen scientific acumen and are nearer to modern ideas than even Maxwell's theory. Faraday thought that the assumption of an æther was not essential for understanding light waves; they are according to him a "high species of vibration in the lines of force". (The modern view following upon the Relativity theory also discards an æther and contemplates vibrations of the electric and magnetic vectors without any thought for a medium.) Maxwell on the other hand attempted a dynamical theory based on the properties of an æther which behaved like an isotropic dielectric and which was assumed to be able to possess both potential and kinetic energy. He put the laws of Ampère and Faraday into a general mathematical form and obtained his famous equations. He also replaced the expression for the electrokinetic energy by one which gives the energy in terms of the magnetic force, by a process of integration by parts wherein the surface integral is neglected on the ground that at great distances it tends to zero; but in this he overlooked the fact that the law of variation of a magnetic field with distance is not the same when the field is varying as when it is steady. However, this expression is not used in deducing his equations which are thus unaffected. According to Faraday, however, it is not the æther that pervades all space but the forces of the atomic centres pervade all bodies, and it is the vibration of the lines of force and not that of the parts of the æther that is responsible for the propagation of electro-magnetic disturbance. The consequence of identifying light waves with electro-magnetic disturbances was to enable the velocity of light to be determined by finding the ratio of the electro-magnetic and electrostatic units of electric force.

Consistently with the above, the effect of material media can be represented by electric and magnetic currents throughout the space occupied by the material medium and these electric and magnetic currents may be supposed to be due to the motion of electric charges and magnetic particles, *i.e.*, the medium can be replaced by a distribution of electric and magnetic oscillators. When an electro-magnetic disturbance passes through such a medium the motion of the oscillators is disturbed and under certain conditions small oscillations will be set up about steady states of motion. The material of the medium may be considered to be transparent to such waves as set up only small oscillations, *i.e.*, those whose frequency is not near the natural frequencies of the oscillatoes. Fresnel's results for the intensity and polarisation of the reflected and refracted waves as well as his results for crystalline media can be obtained on this view without further hypothesis. Faraday's results for the rotation of the plane of polarisation also follow immediately. The view also shows that there are ranges of frequencies for which a medium is transparent and other ranges for which it is not transparent. The calculation in the case of these latter frequencies involves additional hypotheses.

The above theory is not a mechanical theory in the sense that a machine can be constructed whose motions resemble those of light. The form of the electrokinetic energy function leads us to doubt whether all time rates of change can be represented by the motion of points in space. We may have to contemplate time rates of change which do not involve changes of position in space although they satisfy the laws of dynamics. A possible hypothesis is that physical phenomena are due to the interaction of time rates of change which satisfy the laws of dynamics. The Lagrangian function will then be a homogeneous quadratic function of all the time rates of change. In practice some of these rates are observed while others are not; the experimentally deduced Lagrangian function will then be a modified one, not involving the unobserved changes.

## Chemistry.

*President:* PROF. T. M. LOWRY, F.R.S.

### "PHYSICAL METHODS IN CHEMISTRY."

IN his Presidential Address to the Chemistry section Prof. T. M. Lowry has taken for his subject "Physical Methods in Chemistry". Such is the significance of this topic at the present times that it has also formed the theme of a symposium held recently by the Deutsche Bunsen-Gesellschaft at Bonn (*Z. Electrochem.*, July 1934). Some of the many extremely interesting remarks made by the lecturer in his introduction are best quoted in almost his own words: "One of the most important features of scientific progress during the present century has been the renewal of the old intimate fellowship between chemistry and physics. Chemists who are no longer competent physicists and physicists who have little or no sympathy with chemical problems are a great loss to both sciences. The efficiency of my own Laboratory of physical chemistry at Cambridge and the pleasure that I derive from directing it depend largely on the fact

that the workers in the laboratory consist of chemists and physicists in approximately equal numbers, so that we are equally well equipped for work in the older physical chemistry and in the newer chemical physics. Indeed our chief need at the present time is for larger numbers of organic chemists to undertake researches in physical chemistry of organic compounds."

Brief reference is made to some of the principal contributions which physics has made to the progress of chemistry during the present century, such as the theory of atomic numbers, developments in the field of nuclear chemistry through the use of new projectiles for bombarding the nucleus, and the phenomena of X-ray and electron diffraction of molecules. Prof. Lowry then proceeds to give a graphic description of his 40 years of research work on the subject of optical rotation, and how from his first piece of work on the stereo chemistry of $\alpha$-derivatives of camphor, "happy chances" led him on step by step from one discovery to another, from the discovery of *mutarotation* to its interpretation as an example of *dynamic isomerism* and its dependence on extra molecular circumstances. It was particularly observed that an amphoteric solvent must be provided to serve as a complete catalyst for this isomeric change in which a H atom migrates from one position to another (*prototropy*). This discovery was linked up in 1923 to an extended definition of acids and bases as proton donors and acceptors, an idea which was described more fully by Brönsted a few months later. This process of isomeric change can be regarded as an electrolysis of the organic molecule between the positive and negative poles provided by the acid and basic components of the amphoteric solvent.

Attention was then naturally directed to more quantitative studies of optical rotation and its change with the wavelength, *i.e.*, the dispersion. Drude's equation can express completely the rotatory dispersion for transparent media up to the extreme limits of accuracy now attainable. In general *normal* dispersion can be expressed with but one term of this equation, while *anomalous* dispersion requires the use of two terms of opposite sign. Dispersions can also be classified into *simple* and *complex*, according as they require one or more terms of Drude's equation. *Simple* rotatory dispersion, however, does not imply the existence of only one single partial rotation, but merely indicates that the partial rotations of the molecule can in practice be covered by one term of Drude's equation. Thus, in the remarkable case of tetra-acetyl-$\mu$-arabinose H $(CHOAc)_4CHO$, the partial rotations associated with the three asymmetric carbon atoms cancel out, and the whole of the rotatory power is due to the partial rotation associated with the carbonyl group. This gives rise to a simple rotatory dispersion in the region of transparency. In the region of absorption it gives a symmetrical loop, with equal and opposite maxima $[\alpha] = \pm 1200°$, on either side of a zero rotation at 2909 Å. U. The dispersion in the absorption region is a complicated phenomenon, on account of the presence of damping factors which are discarded in Drude's simple equation for the transparent region. The attempts of Kuhn and Braun and of Hudson have been only partially successful in expressing accurately this dispersion. The sugar derivatives tetra-, and penta-acetyl-$\mu$ fructose provide ideal material for an experimental study of the form of the curves of rotatory dispersion in the region of absorption since the partial rotation associated with the carbonyl radical has been isolated automatically by a fortunate process of cancellation of the partial rotations of the asymmetric carbon atoms.

Regarding the origin of optical rotatory power, the real theory may be found by the mathematicians, but is concealed from the chemist, in the papers of Born, who recognised that *four* coupled electrons are required to produce optical rotatory power. Further advances appear to depend on reverting to this basis, in place of Drude's single spirally controlled vibrator, or Kuhn's two dissymmetrically coupled electrons. In the case of camphor we are dealing with an intra-molecular field of force which induces dissymmetry in the highly polarisable carbonyl group, rather than with asymmetric carbon atoms, which in the case of the sugar derivatives referred to, make no direct contribution of any importance to the rotatory power of the molecule.

The attempt made nearly ten years ago by de Mallemann, to predict the sign and magnitude of rotation of a molecule, assumed for purposes of computation single atoms as isotropic spheres. S. F. Boys has recently extended this postulate from single atoms to radicals, and has been able to deduce for four of the simplest alcohols and amines rotations which are of very similar magnitude to those observed experimentally. As this extension to radicals such as $CH_2OH$ is certainly not valid, the agreement is perhaps more of the nature of coincidence. Besides, this formula cannot represent even qualitatively the anomalous rotatory dispersion of aldehydes and ketones in the region of absorption. No theory of optical rotatory power which is limited to the region of transparency can be regarded as satisfactory, and further progress must depend on an intensive study of rotatory dispersion in the region of absorption. When perhaps one has been able to determine by the methods of wave mechanics the conditions under which the electronic cloud of the carbonyl radical becomes optically active, and the factors which determine the magnitude of its partial rotation in order to provide a complete solution for this special case, the way will be paved for a general solution of the whole problem.

## Geology.

*President*: PROF. W. T. GORDON, M.A., D.Sc.

### "PLANT LIFE AND PHILOSOPHY OF GEOLOGY."

THE Presidential Address by Prof. W. T. Gordon to the Geology section of the recent meeting at Aberdeen, of the British Association for the Advancement of Science, deals with "Plant Life and the Philosophy of Geology". The paper is largely historical in character and begins with the palæontological ideas of the Greek and Roman philosophers. In these early times although many geological processes and phenomena were known, there was no science of Geology. Even in mediæval times the idea still prevailed that fossils were produced in the earth by "stone-forming essences"; although there were few like Leonardo da Vinci and Fracastoro who recognised the important fact, that fossils were true organic remains buried in the rocks of the earth's crust. The earlier people must have had ample opportu-

nities of unearthing fossil remains during the excavations for tanks, foundations, etc.; the paucity of references to such fossils in contemporary literature can only be attributed to an apathy and extraordinary lack of interest in them. Gradually, however, the organic nature of fossils was established as a principle of scientific philosophy and even so early as the sixteenth century they came to be studied in the proper spirit and method of enquiry; and during this period fossil plants came in for a lot of attention in the hands of such workers like Palissy, Steno, Robert Hooke, Martin Lister and John Woodward. Thus the stimulation for the collection of fossil plants increased and the literature dealing with them began to grow which involved not only the palæontological aspect but its application to larger geological problems.

Fossil Botany as a Science was initiated by Adolphe Brongniart when in 1828 he published the first part of his "Histori des Vegetaux fossiles", with the illuminating sub-title "Botanical and Geological Researches on the Plants sealed up in the different Rocks of the Earth". This important publication placed the study of fossil plants on a scientific basis and Brongniart well deserves the title of the Father of Fossil Botany. While these researches were based mainly on the study of incrustations of plants, a new method was devised by Henry Witham in 1833 for the investigation of their internal structure by the examination of thin sections. The advent of this new technique at once divided the study of fossil plants into two sections one biological and the other stratigraphical. As a direct result of the development of the study of micro structure of plant fossils we see the recognition of such groups as Psilophytales, Pteridosperms and Caytoniales, groups which throw considerable light on the ancestry of the different phyla of the plant kingdom. Further, similar microscopic studies enabled Kidston and others to show the distinctive nature of the floras in geological times and their utility for stratigraphical correlation. Another phase of research in plant palæontology is the quantitative type which has been explored by David Davies with such striking results in the correlation of coal seams over wide areas, especially from the spore content of the coal. The advent of the new technique recently introduced in 1933 by Hickling and Marshall on the study of bark structures will soon enable us to know accurately the plants that made the actual coal, whether the bark, wood, or spores and in what proportions they have occurred. At the present time not only the land and swamp flora of the carboniferous age has been used as zonal indexes but due to the researches of Garwood, the marine algæ of that age have also been largely employed in zonal correlation.

Having dealt with the Permocarboniferous flora of Europe and North America the author refers to the Glossopteris flora of the Gondwana-land and its association with clearly marked glacial phenomena. The actual causes for such climatic changes and the probable distribution of land and water during this period are questions which still await a satisfactory solution, which will be possible only after a detailed study is made of other contemporaneous floras such as the Gigantopteris flora of China and Korea, the Angaraland flora of Siberia and the upper Permian flora of the Grand Canyon of the Colorado.

Many important results have been obtained from a botanical point of view by the study of the Mesozoic floras and these show few survivals from the Palæozoic period. During upper cretaceous times a sudden change is observable from the Mesozoic to the Tertiary Angiospermous flora. It has been suggested that the Cenomanian transgression was a factor responsible for this change according to Prof. Gordon. This suggestion is valuable and worth exploring. The study of the early Tertiary floras shows the preponderance of arborescent Angiosperms, a feature of tropical and sub-tropical climate and these plants probably migrated from the north to their present habitat.

On account of the clearly marked zonal distribution of plants to-day it has long been held that fossil plants are good indexes of climatic zones in past time. Recent studies have shown that the position in this regard is not so definite as was formerly maintained; and it is possible as Prof. Seward put it that the value of fossil plants as indexes of climate has been over-estimated. While it is no doubt generally true that plants do afford an index of climatic changes and that these changes have been very considerable in past times—the actual explanation of such changes is becoming more and more controversial. New methods of research are coming into vogue and these are discovering new links in the chain of ideas with which fossil plants have affected the Philosophy of Geology.

## Zoology.

*President:* E. S. RUSSELL, O.B.E., D.Sc.

### "THE STUDY OF BEHAVIOUR."

THE address continues the discussion begun by Dr. Gray in his Presidential Address to this section last year, *viz.*, that the organism has properties and potentialities as a whole which are not reducible to the properties shown at the chemical level. It is regrettable that the study of animal behaviour has been largely neglected in the study of general zoology, so much so that it has become the province of physiologist and psychologist "neither of whom is, as a rule, sufficient of a naturalist to appreciate the full biological significance of the behaviour observed in the laboratory". For a complete comprehension of the life processes of an animal, it is obvious that the zoologist must obtain direct information of its behaviour in the field. Interest in field study of animals is alive among both professional and amateur zoologists and one of the most significant developments of recent years has been the growth of the Oxford School of Animal Ecologists established by Charles Elton. Still in England the study of animal behaviour as a science has not taken its appropriate place as an integral part of zoology either in research or in teaching, and this unsatisfactory state of affairs is to be explained by the influence which the metaphysical doctrines of the seventeenth century exerted upon biology. Descartes who in many respects imbibed the philocopic theories of the middle ages and was at the same time under the influence of the physical and cosmological conceptions introduced by Copernicus and Galileo imposed on biology the classical doctrine of materialism with its absolute separation of mind and matter as its working method. This dualistic conception of Nature which has raised the most baffling problems with which

human mind is confronted, has diverted biology from its proper method of investigation. In their ultimate analysis, matter and mind instead of being actual realities, tend to become abstract concepts, "the product of reflective intelligence working upon the data of immediate experience". Subjective experience in certain of its aspects is a function of the organism as a whole, instead of being that of pure mind; and all objective experience is a relation between the organism and the processes or events external to the organism. According to this theory of abstract dualism, an organism is conceived as a machine with "the ghost of a mind hovering round or within it". On this basis the science of animal behaviour becomes an impossibility. The physiologist has nothing to do with mind and the psychologist finds that he can know nothing directly about the minds of organisms. Under these circumstances, the scientific study of behaviour is divorced from natural history and ceases to be an integral part of zoology.

The main business of a zoologist is not to concern himself with the metaphysical views of mind and matter, but to study animals in action, in their natural homes and haunts and in their association with other organisms. The analytical or physico-chemical method of approach is not a fruitful one, but the alternative one of treating the organism as a whole and working down to the parts represents perhaps a simpler and more direct view of living things. There is thus no such thing as living matter, the subject of physico-chemical investigation,—except as part of an organised unity. An organism is an organised unity showing the activities of maintenance, development and reproduction which are directive or purposive and in which it differs from non-living objects. In this conception of the activities of the organisms, the time factor must necessarily enter and the organism is essentially "a spatio-temporal process, a dynamic pattern in time". Viewed from this standpoint, the behaviour of all organisms is reduced to a kind of activity which does not require "mind" as an immaterial entity to explain it. The central position of the modern organismal biology is to substitute the concept of organism for the concepts of matter and mind. The organismal theory does not admit of difference between life and mind, *i.e.*, between the purely vital activities and psychological processes. The behaviour of an organism can be studied independently of its subjective experience and in this study it may perhaps be necessary to use terms of psychological implication. In attempting to analyse a total organic event or process, it may be necessary to break up the behaviour into parts, which are unreal in the sense that they are abstract and can acquire significance only when related to the whole process. It may be necessary to analyse the organic activities for obtaining a deeper knowledge, but the abstract picture so obtained has to be corrected by reintegrating the part in the whole.

The science of animal behaviour must begin with a study of the natural history and ecology of the animal. The zoologist has to find out how an animal conforms to its ecological norm, how through adaptation both in structure and activity the animal maintains itself, defends itself against enemies and procures food, and this study of habits is the basis of the science of animal behaviour. Very often a single directive activity is part of a general directive process of long range which may take months to reach its goal and in order to understand it, we may have to relate it to the general process of which it is a part. The general rule of organismal biology is that the whole life-cycle of activity must be regarded as the primary thing and the parts of it isolated for study must be integrated in the whole activity.

How is behaviour initiated? According to Pavlov the answer would be that behaviour is essentially an automatic response to external or internal stimuli. This analytical and physiological view is an incomplete explanation as has been shown by K. S. Lashley and the Gestalt psychologists, and perhaps K-Koffika's theory comes nearest to express the truth. According to the latter author reflexes are passive modes of behaviour which depend on the fact that some stimulation has taken place, while instinctive behaviour is, by contrast, significantly active in its search for stimuli. A great part of the behaviour of animals is normally response to needs and not to external stimulation, though it is true that to a considerable extent, behaviour is influenced by events in the animals' environment. The whole trend of modern work on the perception of animals establishes that they do not normally respond to simple physico-chemical stimuli but to more or less complex whole-situations. This is the cardinal point in Gestaltian theory.

The address sets out to establish two central points. One of them is that biology must get rid of the theories of materialism of the seventeenth century imposed upon it, because the metaphysical Cartisian doctrines do not accord with the modern development of sciences and are not adapted to the study of living things. The second point is that an organism is to be conceived as a four-dimensional whole or directive cyclical process and that the relation of behavioural activities to physiological is not the relation of mental to physical activities, but is relation of a whole spatio-temporal directive process to its parts.

## Geography.

*President*: PROF. ALAN G. OGILVIE, O.B.E.

### "CO-OPERATIVE RESEARCH IN GEOGRAPHY WITH AN AFRICAN EXAMPLE."

THE body of knowledge which has been incorporated in geographical literature represents contributions by workers in different fields, and geographers therefore have, in dealing with the data placed before them for synthesis, drawn conclusions from them, without possessing the opportunity of even verifying them. It is almost impossible to obtain an adequate picture of the World in all its multifarious aspects until and unless the component parts of this amazingly bewildering picture are fully represented on the canvas. Manifestly it is beyond the powers of man to be an expert in all the branches of knowledge and the geographer has to rely on the facts collected laboriously by other workers and where detailed information in any department of knowledge is wanting the observations and generalisations of geographical science must rest on insecure foundations.

The idea of collaboration in geographical research is not new. The method generally

pursued consists in the concentration upon a selected region of work by specialists in different sciences, who produce individual monographs used for the concluding geographical volume in which all the facts are linked and synthesised. Our information of Lake Balaton and its vicinity is due to such co-operative effort undertaken by the Hungarian Geographical Society in 1891, in which nearly a hundred contributors were engaged. The International Geographical Union also promotes co-operative research in various subjects, the majority of which are of a physical character. There are similar organisations such as the International Glacier Commission, the Royal Geographical Society and Sir John Murray's Survey of Scottish Lochs, engaged on promoting geographical investigations. The International Geographical Commissions deal with the problems of human geography. Types of Rural Habitation and Racial Cultures, the studies of German geographers upon settlements in the various regions of the world, have produced a mass of information most valuable to the development of geographical science: but the most striking instance of organised geographical investigation designed to be of definite advantage to national planning is that of the American Geographical Society relating to problems of pioneer settlement throughout the world.

The Continent of Africa has during the past decade received increasing interest and the information we already possess of its people, its structural and physical configuration, fauna and flora, the lake systems and the great water-ways, its natural products and climate, is bewildering. The future of the African races holds special interest and before arriving at a considered judgment, it is evidently necessary to understand the native population as they are, the life they lead, the beliefs they hold, the customs and rites they practise, their family and social organisation and their occupations and special interests. These are matters, no doubt, appropriate to anthropology, nevertheless anthropology has much to say in regard to the geographical controls and influences affecting the material life of these people and information received from anthropological studies, must be supplemented by those derived from investigations of the physical environment. The many gaps that exist in our knowledge of some of the great continents will have to be bridged by the collaboration of experts working in inter-related fields. With the object of completing our knowledge of the human geography of Northern Rhodesia, a Research Committee of the British Association was appointed and the information collected by this Committee in respect of Inter-Tropical Africa is summarised in the address.

The principal features of the body of knowledge obtained by the Research Committee are that the results were obtained within the geographical section: they represent new material contributed to the geographical synthesis of an extremely interesting region; they relate to specific localities and record the human actions together with explanations in so far as they are traceable to special environmental factors; they direct attention to a close understanding of the conditions of native's material life which, though simple, is varied. If the questionnaire issued by the Research Committee should be answered as comprehensively by the district officials in other parts of Africa as those in Northern Rhodesia have done, and if the same questionnaire were addressed to others working in South Asian Continent and adequate response received, there is every hope that our knowledge of the peoples of these vast terrestrial areas would become complete.

## Economic Science and Statistics.

*President:* H. M. HALLSWORTH, O.B.E.

### "THE FUTURE OF RAIL TRANSPORT."

WITH the introduction of automobiles and the development of coastwise traffic, the Railways are confronted with such a keen competition that their revenues are in grave danger of being permanently affected. Will the Railways be ultimately displaced? This critical position for the railway systems created by competition is universal, and forms one of the gravest problems pressing upon the nations. Since the War, partly on account of contraction of internal trade and economic depression, and partly on account of increasing competition, the earnings of the Railways have steadily fallen and the retrenchment in the railway system has thrown out of employment a large number of workers and officials besides depreciating the stocks and shares. The development of motor, coastwise and even air transport has been remarkable during the same period and the great convenience of this mode of conveyance accounts for its increasing popularity. The traffic which the Railways have lost can hardly be expected to be regained. The situation becomes piquant when we realise that the coasting trade bids fair to compete successfully with motor transport, through the evolution of Diesel-engined shallow-draught vessels capable of working into the small parts of the country, and, being fitted with the modern system of storage and unlading, can dispense with dock facilities. Perhaps the only relieving feature is that the rail traffic still holds its own in regard to transport of parcels over long distances.

The creation of an adverse position such as this is entirely due to the apathy and want of imagination on the part of the Railway companies. They did not realise the extent to which the road traffic would develop and did not adopt measures to cope with the new competitor. Complete confidence in their established position rendered them deaf to the complaints on the part of the people who resorted to the railway service, and the authorities were too slow to provide comfort to passengers and ensure safety to goods. And so long as there was no competitor, the position of the railways was unassailed but things have greatly changed. The railways have to study the needs of their customers, attend promptly to complaints by altering an existing mode of operation or the kind of service offered, even if the demands of the passenger and the trader are expensive to meet: and in this acquiescent mood lies the hope of regaining part at least of the traffic now captured by the successful rivals. It is true that the Railway (Road Transport) Acts have conferred on the Railway companies road powers, by which they are permitted to own and operate road vehicles in any district to which access is afforded by the system of the companies. The companies may feel that this liberty puts the

competition on an equitable basis, but there are other conditions and notably the age-long prejudice against them, which might still prejudicially affect their prosperity.

In the complex organisation of trade relations and the demands of the market, the distribution of traffic on an ideal basis must be baffling. The difficulties are recognised by the Royal Commission on Transport and the Salter Committee and they have pointed out that it is impossible to decide what railway services are desirable in public interests and what road traffic and coastwise shipping or what goods should in national interest be sent by rail, road, canal or ship. The ideal distribution of traffic could only be brought about if it were possible to secure that each piece of transport service, by whatever mode of transport it was effected, was charged for at a rate sufficient to cover its true cost of production. The difficulties of computing such costs are manifestly great and especially so in the case of both rail and road transport; but a formula has to be devised, in the stress of competition is to be relieved, based on the division of functions between road, rail, canal and shipping and on considerations of cost to the operator, the price to the consumer and to the community. No formula can be perfect in view of the real distinction between the cost of providing a means of communication which is of general public benefit and the cost of its use by the customer. The difficulties of getting the public to approve of any such scheme of adjustment must be borne in mind.

It would be fruitless to suggest that the great advantages conferred by road and coastwise traffic should be forfeited to the Railway companies and according to H. M. Hallsworth, the best solution is that the Railways should cease as companies and should come to be regarded as transport companies, undertaking a given piece of transport by that means or a combination of means which may appear to them as the most economic and at the same time most suited to the demands of the traveller and trader. This solution would imply the absorption of road, passenger and goods, services, and is sure to give rise to opposition. If the whole volume of passenger and goods traffic can be handled by a unified management of Transport Companies, it can be carried on on a more economic basis; this of course infers that the monopoly companies have to be maintained at a high level of efficiency. The competition, despite all arrangements, is bound to be there: the railways will also continue to provide service in cases where such service is most appreciated. It will regain its popularity if its mode of transport is economic and meets satisfactorily the increasing demands of the nation. Perhaps the experiment of bringing all the existing modes of transport under one management may solve some of the present difficulties.

## Engineering.

*President:* PROF. FRANCIS G. BAILY, M.A., F.R.S.E.

### "SOURCES OF CHEAP ELECTRIC POWER."

AT present the bulk of power in Great Britain is generated in power stations located near large cities and using superior coal, the grid merely serving as a link between these power units. At the same time there are sources of cheap power going to waste, which could be utilised if a change could be introduced in the general scheme of power production and distribution so as to utilise the grid system not merely for distribution purposes but also for collecting power wherever it can be obtained economically.

Of the potential sources of cheap power by far the most important one is waste coal which at present is either thrown away or used very uneconomically for supplying power to the mines. It is of very inferior quality and unsuitable for transport or cleaning, and can only be used profitably in pit-head stations. It represents roughly one-tenth of the total quantity of coal raised, and it is estimated that if 5 *s.* per ton is offered for this waste coal 18,000,000 tons of it with an average calorific value of 10,000 B. Th. U. per lb. would become available in Great Britain. This is 50 per cent. more than the total amount of coal used in British power houses at present.

In steam power stations installed at pit-head for utilising this coal the cost of generation would, at all power factors, be 0·05 pence per unit less than that in the largest modern stations. As the cost of generation in modern stations is about 0·25 anna per unit at 0·4 load factor, the saving is appreciable and would be greater for higher load factors. As most of the mines in Great Britain could be grouped together it would be possible to instal large stations of 100,000 kW. capacity, which could be operated very economically. Even in cases where smaller stations of 20,000 to 30,000 kW. have to be installed the cost of production would be little different from that in the larger stations because, on account of their being tied to neighbouring stations by the grid system, no spare plant would be necessary and they could be of a very simple type containing two large units. The total cost of generation (except for rates) in an actual 4,000 kW. station with 2 units operating at 0·7 load factor and using a very low grade coal at 3 *s.* per ton, containing 40 per cent. moisture and ash, is only 0·137 pence per unit.

Other sources of cheap power are also discussed. Many industries use steam at about 50 lbs. pressure which is generated in low pressure boilers. If the steam were generated at high pressure, say 350 lbs., utilised in turbines for generating power and exhausted at low pressures for industrial processes, power could be generated at a cost not exceeding 0·1 pence per unit. Thus the works could obtain their entire requirements for power at a very low cost and the balance could be fed into the grid system for distribution. Likewise, the low grade gas from blast furnaces could be used for generating power at a low cost. The cost of generation in hydro-electric stations is also discussed and it is concluded that except in the Highlands of Scotland hydro-electric power would not compare favourably with steam generation.

Regarding the cost of distribution, since the population in Great Britain has gathered to a large extent round the coal fields and there are practically no towns, except the sea-ports, that do not lie within easy reach of them, nearly two-thirds of the population would be within 40 miles of the coal fields and the cost of transmission from pit-head stations at 132 kV. (estimated at 0·02 pence per 100 miles at 0·4 load factor) would be less than 0·01 pence per unit.

Consequently, generation in pit-head stations would result in an economy of 0·05 pence per unit as compared with generation in the large power stations located near towns. A plea is also made for the reduction of the municipal rates which are exorbitant and often amount to 0·1 pence per unit, which is of the same order as the cost of coal. If this is reduced to 0·05 pence there would be a further saving of 0·05 pence, and the selling price of energy could be reduced by 0·1 pence. Since the present selling price for domestic heating is only 0·5 pence per unit, a reduction amounting to 0·1 would bring in considerable additional domestic heating load. Similarly, a considerable improvement in the railway and metallurgical load may be expected from a reduction in the selling price. As the load increases, there would be a corresponding improvement of the load factor and the density factor, resulting in a reduction of the cost of generation and distribution, and a further reduction in selling price of energy would become possible. Thus, the process once started by the reduced prices due to the utilisation of sources of cheap power and a reduction in the burden of rates would gradually gather strength and put the electric supply industry on the road to considerable development.

It is not proposed that these new supplies should be introduced suddenly and the present power stations replaced by pit-head stations, as that would involve the loss of considerable central station capital, but it is suggested that full advantage should be taken of the facilities afforded by the grid for the collection of power wherever it becomes available at a low cost, and a new policy should be planned out, so that the change can be introduced gradually as the electric supply industry develops. The present rate of expansion indicates that in ten years' time the station power will be at least double of its present figure. This normal growth together with the closing down of the present small stations will give opportunity for a large-scale trial in a few years, while every improvement in methods of electric transmission of power will place the pit-head station in an increasingly stronger position for supply to large towns.

## Anthropology.

*President:* CAPT. T. A. JOYCE, O.B.E.

### "THE USE AND ORIGIN OF YERBA MATE."

THE subject of the address may seem at first sight to be a little removed from anthropological studies, but from the standpoint of the President, an exposition of Ethno-botany is of the highest importance. The wide-spread use of stimulants, narcotics and food plants throughout the world has an important bearing on culture diffusion and in a large number of cases, the spread has been so rapid that the original home of the majority of "drugs" and "drinks" is lost in obscurity. The cultural basis of foodstuffs is not widely appreciated; they affect profoundly the ideals of the people, their general outlook on life and the events and processes of the objective world and in their relations with other nations. The consumption of purely vegetable diet seems to favour subjective idealism and metaphysical subtleties, suppressing instincts of enterprise and capacities for colonisation. On the other hand, a meat diet would appear to promote a more practical type of religion, love of freedom and open air, and a restless energy which manifests itself in expansion and conquest.

The term *maté* originally denoted a gourd or silver cup in which the decoction of the leaves and shoots of the plant *Ilex paraguayensis* which is indigenous to Paraguay and Southern Brazil, was prepared, and the word is now transferred to the drink which is drunk through a tube known as *bombilla*. The origin of the practice of infusing the leaves of *ilex* is very obscure. The earliest mention of the drink is found in a book by Nicolás Durán, a Jesuit missionary in Paraguay (1626-27), by which time the beverage had become popular throughout South America. Although the Spanish occupation of South American states dates from 1516, and acute observers such as Ulrich Schmidt, Cabeza de Vaca, Sao Francisco, Nicolas Monardes and Diaz Guzmann, who travelled in the occupied territory and have left interesting records of great ethnological importance, have made no reference to the use of *Yerba maté*. Pinelo writing in 1636 refers to an author Robles Cornejo where he says a full account of the herb is given; and Cornejo's work probably was written in 1617. So far the evidence available would seem to show that the drink is probably a native discovery developed and elaborated by the Jesuit missionaries who settled among the native population. But according to Monardes and Conjero it would appear that the use of the leaf of *ilex* was unknown to the natives prior to the establishment of Jesuit missions, except perhaps for chewing.

As regards the properties of the *ilex* which have won for it so widespread a popularity, it is supposed to contain all the active alkaloids of coffee and tea together with an aromatic oil and gluten. The effects of *maté* on the human system and the modes of preparing this beverage have been described in great detail by Nicolás Durán and Nicolas del Techo. The discovery and popularisation of this drink in South America are closely associated with the history of Jesuit settlement in that continent from 1609 upto 1774 when the reservation was added to Crown properties. By this time *ilex* had become much an important article of local industry and export that in 1807 the profits derived from it amounted to £ 100,000 annually.

It has been suggested that the native name of *ilex*, *Caa* which is only a generic term for tree, has some relation to the Chinese C'ha meaning tea in Pekinese, Mandarin and Cantonese dialects. Tea was first brought to Europe by the Dutch in the early seventeenth century from Bantom whither it was imported by Chinese merchants from Amoy where it was called Tē. The first mention of tea in Western literature is in Maffei's *Historica Indica* published in 1558. It is not inconceivable that the Jesuits of the period, looking for a substitute for tea which was by then introduced into Southern Europe, also introduced the Chinese word which was mispronounced by the natives. The missionaries encouraged the use of the leaves of *ilex* among their Indians to whom it was served out with rations, probably with a view to wean them from indulgence in intoxicating drinks. They succeeded in building up a most flourishing and lucrative industry before they were expelled and its condition in the first half of the nineteenth

century is vividly described by J. P. and W. P. Robertson in their "Letters on Paruguay". The development of the *Yerbales* or *ilex* plantations by the Jesuits is interesting. The economic importance of the leaf combined with the fact that the tree grows in inaccessible swampy mountain valleys, led to the inception of efforts to bring it under cultivation. In the wild state, the tree is propagated by birds which eat the seeds and digest their gluten envelope; and seeds which have passed through this process of preliminary digestion germinate and grow better than the trees attempted to be raised by planting the seeds without stripping them of their gluten coat. The groves planted by the Jesuits in their communities were extensive, consisting of hundreds of thousands of trees, and from this one may easily judge the extent of the economic importance attached to the industry and the rapidity with which the use of the beverage was spreading.

The address is intended to excite the interest of young men trained in Botany in the bearings, that their studies in economic aspects of the science, have on the cultural history of the peoples of the World.

## Psychology.

*President:* SHEPHERD DAWSON, M.A., D.SC.

"PSYCHOLOGY AND SOCIAL PROBLEMS."

SOCIAL problems are partly material and partly mental. Great progress has been made in the solution of material problems; the investigations of the physical and biological sciences have given no increased control over material resources; the energy values of foods have been ascertained and the amounts required for doing works of different kinds satisfactorily and efficiently, have been determined; diseases have been brought under control and generally national health has greatly improved. Comparatively little attention has been paid to the mental aspects of social welfare and we have no accurate data concerning the distribution of intelligence and aptitudes among the people, the predisposing causes of idiocy and other forms of mental deficiencies and the mechanism of inheritance by the offspring of the strong and weak points in the parental character. It is manifest that for a proper understanding of the numerous problems that arise from life in a community and for national planning, the social, economic and political studies are just as important as those of human mind. The solutions to the mental problems are to be found ultimately in the forces which move men to action in their inherited capacities, in their acquired characters, in the mentality of the groups to which they belong and in their organic relationship with such groups. We do not possess accurate scientific data in respect of the number and nature of innate human tendencies and their operation in or influence on social life or how these tendencies affect personal behaviour. There are observations and speculations on this topic, but they lack the objectivity and precision which science demands. Racial inborn tendencies in the children are of great social importance for practical life because their future education has to be built on them: therefore our knowledge of their potentialities, how they are evolved and how they express themselves in action, must underlie all educational endeavour.

Social problems can be investigated either from the point of view of the individual or from that of the group to which he belongs. This investigation must not be, however, exclusive, but complemental, for the problems of the individual are also the problems of the society, however complex the social group may be. The social problem or the educational problem must at all times be how to fit the individual to the social structure and the group to the individual. The solution to this problem demands some knowledge of the natural endowments of the individual, the practical and intellectual heritage of the group and of the methods of making the most by their mutual interaction. In attempting to assess scientifically the natural endowment of an individual and social achievements, it is clear that a distinction is to be recognised between human ability and capacity. "Ability is actual, capacity is potential." A satisfactory measurement of ability or capacity must always be difficult on account of the adaptability of the human organism and the best of examinations can only give us a blurred picture. The conditions of chemical and physical laboratories cannot be reproduced in the investigation of human and social phenomena: we can obtain only approximations to these conditions. All kinds of capacities are tested in psychological laboratories with varying success and it may be possible at some future date to evaluate the facts with some approach to accuracy with which physical characters can be assessed. What is needed is more extensive and more co-operative work. The results already gathered have a great social significance. They have been obtained from extensive studies of children of all ages, races and grades of society and they may be used in getting a fairly reliable information regarding the distribution of intellect in a given population as a whole and the various professional, social and economic spheres, and its bearing on the fertility, disease and reactions to environmental conditions. They point to a method of getting reliable information which will throw light on the puzzling problems of mental inheritance and on the manner in which the educational wastage can be turned to best account both for the individual concerned and the society.

In the investigations into the inheritance of intellect much reliance has been placed on the empirical methods based largely on social and professional success. These enquiries have yielded very often tantalising results; successful and enterprising parents are not as a rule blessed with promising children, who sometimes come of parents obscure and even defective. The theories of genetic inheritance which have proved so fruitful in the investigation of the physical characters of plants and lower animals, are capable of being applied to human anatomical and physiological characters, such as the colour of the skin, hair and eyes, stature and susceptibility to disease, and it is probable that they apply also to mental characters. The difficulties in all investigations into the structure and potentialities of the mind, must be those relating to the control of the environmental factors, the designing of satisfactory tests for adults and the isolation and definition of simple mental characters. Investigations into all these fields necessarily depend upon the co-operation of psychologists, teachers, experimental

biologists, medical men and statisticians in so far as the study of mental inheritance resembles that of most other social problems.

## Educational Science.

*President:* H. T. TIZARD, C.B., F.R.S.

### "SCIENCE AT THE UNIVERSITIES."

(Some Problems of the Present and Future.)

SCIENTIFIC education and research have introduced in modern life social amenities, economic progress, transport facilities, better health and wider opportunities for interesting and useful work, such as few could have visualised half a century ago. Even a politician believes in scientific research but all who talk about it do not necessarily understand its full connotation and implications. The agreed educational policy in all enlightened countries is that scientific studies should receive greater emphasis than the humanities and it is obviously of great advantage to the state if all its citizens have received training in some form of scientific studies. However, it is not quite clear what exactly we mean by a general scientific education. There is bound to be disagreement when we come to define the extent and character of scientific studies in the curricula of secondary and intermediate stages of education. Moreover, how is it possible, in a few years, to give the pupils an adequate insight into the beauties and wonders of the physical and biological sciences or to convey a conception of the law and order in the universe and an appreciation of the discipline and method of research, without running the risk of leaving them with a mere smattering of uninspiring knowledge. Our experience of scientific teaching in the schools is too recent and insufficient to be able to deduce any generalisation and the experiment tried in a number of ways and in different kinds of schools needs sympathetic encouragement. The general growth in the teaching of science in the secondary schools has naturally been accompanied by a great increase in the number of young men electing scientific courses of study in the universities. This growth is rendered possible by provision of public money, and it is estimated that the public expend in one way or another nearly £ 200 a year on each student of science, with the possible exception of students at Oxford and Cambridge, who are more richly endowed from private sources. The provision of public revenues for educational purposes imposes on the teachers and members of the administrative staff the additional responsibilities which create for them the position of public Trustees who have to examine the expenditure more scrupulously and have continually to ask whether additional expenditure can be justified and whether the public gets in return the value for supporting the educational institutions. Perhaps in the middle ages when the economic stress was not half so keen as it is in modern times and the demands of the society were less complex and numerous, the educational adage "knowledge is its own reward" might have been accepted by the public, but the conditions of life in the present age are entirely different and in some measure the educational institutions must assume the responsibility of training the mind of young men without neglecting the training of the hand and make them sufficiently resourceful to enable them to attack with confidence and success the new problems that are perpetually arising in the rapidly changing world.

The present tendency of scientific education in the universities and schools is to produce experts with a corresponding impoverishment of other faculties of the mind. There are other things besides science in life and the variety and richness of a community have to be adorned by knowledge other than that which belongs to Physics, Chemistry and Biology. Specialisation for many must necessarily imply ignorance of each other's general interests: it is doubtful whether it enables the expert to live a full and rich life of usefulness to himself and to the society of which he is a member. What the world of knowledge might gain must be presumed in cases of overspecialisation as a gain to the society as well. Nevertheless specialisation cannot be for all and in the attempt to reach it, many a career which may otherwise be successful, is practically ruined. All University Education in science is designed primarily to train the young men for learned professions; a few graduates in science break adrift and turn with success to other occupations such as law, administration, journalism and so forth, but rarely politics. A hundred years ago it was not difficult for a scientific man to follow in detail the work of others: now it is as much as a specialist can do to keep abreast of the progress of knowledge in the particular field in which he is interested. It is impossible for anyone to study science in the University as a general education, as men study classics, history and philosophy.

During the present century there has been a wide and incessant demand for scientific education and scientific research owing to the increasing recognition of the fact they are the foundation of national well-being and prosperity. Scientific discoveries have altered the face of society throughout the world and even an administrator often finds himself in situations where a little scientific training would serve him in good stead. It is true that accumulation of scientific knowledge is bewilderingly stupendous, but the tendency on the whole has been to make the general principles and methods more clear and easier to grasp, because the several parts of this structure cohere well into one unit. A scientific training will be all the better if it is made to include the study of the historical and philosophical background of science. This little reform will render clear to the youthful minds the law and order in the universe and make them realise that scientific training is organised discipline of the mental faculties and scientific research is only a quest of truth and the spirit of all scientific studies is service to humanity.

## Agriculture.

*President:* J. A. S. WATSON, M.A.

### "SCIENTIFIC PROGRESS AND ECONOMIC PLANNING IN RELATION TO AGRICULTURE AND RURAL LIFE."

ALMOST from the earliest times, improvement in agriculture has determined the progress of the human race. The progress may be one of increase in numbers or rise in the standard of living. The population has increased enormously in many parts of the world, but in others,

especially in some of the Western countries, it has remained more or less static. The address deals with some of the problems of the latter.

Contrary to the predictions of Malthus and others, agricultural production has increased enormously in recent years. The opening up of new areas in different parts of the world, increased yields through use of improved strains and application of chemical fertilisers, reduction in cost of labour through introduction of new mechanical devices, better facilities for transport and marketing—all these have led to excessive production and consequent fall in prices.

The present position, which might have been hailed at other times as most desirable, has only brought on acute economic distress to the farmer whose position has become increasingly unendurable. Various expedients have been devised to improve his lot and to ensure his getting a fair return but most of them are only of the nature of palliatives and do not touch the root of the trouble. Sound economic planning of farming practice is the only means of avoiding the inevitable neglect of agriculture and consequent rural depopulation. This would, no doubt, be very difficult to carry out, but the situation should, nevertheless, be faced in the proper scientific spirit. The agricultural possibility of each area should be carefully investigated with special reference to the demand for the produce and the return that may be expected. Wherever possible, cheap mechanical device should be introduced and human labour so allotted as to ensure maximum output through intense specialised knowledge. The holdings should be greatly enlarged and the scope of production considerably widened. With organization of "factory farming" of this type, it should soon be possible not only to relieve the present situation but also to ensure a happier and more contented rural life.

# SUPPLEMENT TO "CURRENT SCIENCE".

## Reviews.

NATURE AND LIFE. By Alfred North Whitehead. (Cambridge. Printed by W. Lewis, M.A., at the University Press, 1934, pp. 96 ) Price 3*s*. 6*d*. net.

Brilliant scholarship adorns the pages of this little book. It comprises two lectures which the author delivered before the University of Chicago in October 1933 and the University possesses copyright in the United States of America. Dr. A. N. Whitehead has attempted in these two lectures to correlate the World of Science with the worlds of religion, art, letters and morality with the object of establishing that Nature itself has processes, goals, beauty and values.

Descartes' influence upon European thought was profound and continued for the last two centuries. His bifurcation of Nature into matter and mind has raised intricate problems in science. As to its effect on philosophy, Professor Whitehead writes as follows:

"The seventeenth century had finally produced a scheme of scientific thought framed by mathematicians for the use of mathematicians....The enormous success of the scientific abstractions, yielding on the one hand *matter* with its *simple location* in space and time, on the other hand *mind*, perceiving, suffering, reasoning but not interfering, has foisted on to philosophy the task of accepting them as the most concrete rendering of fact. Thereby modern philosophy has been ruined. There are the dualists, who accept matter and mind as on equal basis, and the two varieties of monists, those who put mind inside matter and those who put matter inside mind. But this juggling with abstractions can never overcome the inherent confusion introduced by the ascription of misplaced concreteness to the scientific scheme of the seventeenth century."

These thoughts find a fuller exposition in "Nature and Life". The main doctrine of Professor Whitehead is that neither physical Nature nor life can be understood unless we fuse them together as essential factors in the composition of "really real" things whose interconnections and individual characters constitute the universe. The modern conception of matter and mind is that they, in their ultimate analysis, are imperceivable; we only perceive relations or events. The "mind" is conceived as an extended, immaterial thinking entity. If "life" were defined as a "spatio-temporal" process, the definition of "matter" cannot be fundamentally different. Our notion of "soul", "life" and "mind" must at all times, whatever may be the progress of scientific analysis and philosophic thought, remain vague, much more vague than our idea of "matter". Consciousness both of self and of "relations" and "events",—a distinctive property of life,—is far too elusive. Its power and characteristics seem to be limited, however, by "mind" through which it functions. These are problems which have perplexed the scientists and philosophers.

This little book is an able exposition of the doctrine of realism and is a most stimulating contribution to modern philosophy.

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LIFE AND LIVING: A SHORT STORY FOR CHILDREN. By E. P. PHILLIPS, M.A., D.Sc., F.R.S. (S.Afr.). (L. Reeve & Co., Ltd., Lloyds Bank Buildings, Ashford, Kent, England. pp. xiv+152, 1933.)

This book is worthy to be read not only by children but also by the educated adults. It is true that the book is intended to be an elementary treatise on Biology, but the amount of information contained in it is surprisingly full and varied. Every pupil in the High School ought to possess a copy of it and we have no doubt that he or she will read it with profit, diligence and enthusiasm.

It is obvious that every person ought to know something about the fundamental facts and phenomena of life which will give him an insight into his position in the scheme of things and on which the art of living depends. Children should at an early stage be introduced to the truth about life and about themselves. The book is written in a way that any parent who is himself intelligent and resourceful, can hold talks with his children on problems of sex, population, heredity and other topics of great social and scientific interest and about which there is any amount of senseless prudery.

There are twenty-two chapters. The topics have been carefully chosen and treated with great clearness and accuracy.

Chapters XIX and XX deal with the teachings of the great prophets and of religion. We cannot go through life like perpetual blisters and religious ideal is something worth living for. The world around impresses on the mind of children with wonder, awe and mystery and later in the course of proper scientific education, they are bound to discover law, order and directiveness in the phenomena and processes which it is the purpose of their studies to explain and elucidate. If a scientific outlook is indispensable to every educated citizen for discharging his civic duties, a religious spirit is equally necessary for his right conduct in social relations. The steadying influence of discipline which religion (not dogmas) imparts to character, is still the pivot of all human institutions, and its educational value is not to be minimised. Chapter XXI is devoted to the consideration of moral conduct. Of course the moral sense is capable of being developed through scientific instruction, but for its consolidation, the assistance of religion may also be invoked. The earlier chapters treat of the fundamental facts of biology in a simple and clear style.

The book is a chaste one. Every boy and girl ought to read it. Most of the illustrations are self-explanatory and vivid. The book is to be provided with an index which it lacks for the present.

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EARLY FORERUNNERS OF MAN: A MORPHOLOGICAL STUDY OF THE EVOLUTIONARY ORIGIN OF THE PRIMATES. By W. E. Le Gros Clark. (Bailliere Tindall and Cox, 7 & 8 Henrietta Street, Covent Garden, London, pp. xvi+288, 1934.) Price 15*s*. net.

Zoologists and physical anthropologists will find this book invaluable in the study of the evolution of the primates as offering an estimate of the real position of man in the zoological scale. We can hardly form a correct concept of man's phylogenetic origin, without a proper perspective of the evolutionary development of the whole order of primates. While there is a general acceptance of the thesis that man is descended from some lower forms of life, there is by no means unanimity of agreement among biologists as to the exact line by which he attained his present status. Any comparison with the higher apes will only reveal similarities of anatomical structures which alone will be inadequate for establishing human phylogenesis, for they represent the culminating points of the divergent trends of the evolutionary process. The question of relationship of man and his precise position in the group of primates is to be investigated from the standpoint of the evolutionary development of the primates as a whole. The evidence in favour of genetic relationship is derived from the investigation of the data obtained from anatomical, palæontological and embryological researches and the book under review deals mainly with the morphological aspects of the study. The evidence which palæontology and embryology offer, though in the present case it may not be abundant, throws clearer light on the actual lines along which evolutionary development has progressed. At present we have to rely more on the evidence furnished by comparative anatomy of the existing forms and also of the fossil remains recently discovered.

In the scheme of classification adopted by the zoologists, man is placed at the head of the sub-order Anthropoidea, which is distinguished by a definite assemblage of characteristics such as a capacious skull, the forward position of the eyes, the mobility of the facial muscles, the use of fore-limbs as a grasping organ, flat nails on the phalanges and the absence of muffle. The family Hominidæ is closely allied to the family Simiidæ which includes the tailless apes. The structure of the human body is fundamentally like that of the higher apes and there is hardly any detail of structure in human anatomy that is not represented in the latter, although the assumption of an erect posture by man has resulted in characteristic specialisations of the pelvis and viscera, the fore-limbs and the foot. The "brain" is the most exclusive possession of man, exceeding in relative bulk that of any ape and in function surpasses them all. Still, the structural and functional relationships are all parallel. The book is devoted to a critical examination of the evidence of skull, teeth, limbs, brain, sensory organs, alimentary system and reproductive organs. Chapter X deals with the relationships of the insectivora with primates. The tree shrews (*Tupaioidea*) in many of their features resemble the primitive primates so closely that some zoologists have deemed it legitimate to remove the family *Tupaiidae* from the group Insectivora and include it among the primates. In view of the increasing bias in favour of such an inclusion, the book devotes considerable space to examine the

anatomical evidence for such a procedure. This evidence leads to the conclusion that the tree shrews are more primitive than even *Prosimiae*, but on the other hand if the fossil forms are taken into account especially with reference to *Anagale*, *Plesiadapids* and the early *Notharctinae*, it becomes evident that the structural gaps of the existing forms vanish. The last chapter of the book on the Evolutionary Radiations of the Primates deals with the problem of the degree of parallel development undergone by the various groups of primates after their early evolutionary segregation and separation from the common parent-stem. In this chapter the evidence of the various anatomical systems are collated and synthesised in order to provide a comprehensive picture of the phylogenetic history of the primates. The phylogeny of the primates commencing in an ancestral form of lemuroid type, has diverged along four or five lines of evolutionary development, culminating at successive levels in the modern lemurs, Tarsius, Platyrrhine and Catarrhine monkeys, anthropoid apes and man. The living members of each group must be recognised as the few survivals of a whole series of evolutionary radiations which diverged from the beginning from a generalised stock of placental mammals, and which developed evolutionary potentialities of their own in diverse directions.

This book is undoubtedly a valuable contribution. It gives us a clear and comprehensive account of the recent researches into the comparative anatomy and palæontological materials of the primates. Zoologists and Physical Anthropologists will find in the book a mass of information arranged in a cogent and logical fashion, which they will have to search otherwise, among original papers, scattered in a number of journals and magazines. As usual, bibliographies are given at the end of each chapter. Le Gros Clark undertook a great task and deserves warm congratulations on its successful and satisfactory termination.

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THE CAUSES OF EVOLUTION. By J. B. S. Haldane, F.R.S. (Longmans, Green & Co., London, New York, Toronto, 1932, pp. 215.) Price 7*s.* 6*d.* net.

The book is based on a series of six endowment lectures delivered in January 1931 at the Prifysgol Cymru, Aberystwyth, founded by the munificence of the Davies family. One of the conditions of the endowment is that the substance of the lectures is to be published in book form. Professor Haldane devoted these lectures to "A Re-examination of Darwinism". In the preface to the book, the author advises readers who are not acquainted with the general principles of biology to skip slightly over Chapters II and III which give a comprehensive summary of the recent developments in the field of genetics which he uses in support of his argument; and the mathematical interpretation of the problems of variation contained in the appendix will appeal only to a limited section of biologists. The greater part of the approach to the subject is through the mathematical route and the use of calculus is becoming increasingly indispensable for obtaining a clear concept of the possibilities and direction of variation and the limits of their inheritance. It is, however, difficult to suppose that the rigorous quantitative methods of the physical sciences are suitable for researches in biology, even in the case of genetics. Within recent times the statistical and metrical methods have been employed with considerable success in the elucidation of the obscure problems of heredity. The results can be measured. The causes are brought under experimental control. They give us an insight into the processes taking place in Nature and, in some measure, the extent and character of differentiation can be predicted. The application of mathematics to biological investigations first introduced by Pearson and his colleagues has tended on the whole to become more general as a convenient and useful method in dealing with the numerous data on the inheritance of structural variations and other continually varying characters of organisms.

In view of the persistent and voluminous criticism to which the Theory of Natural Selection has been subjected since its definite formulation, it is not surprising if a few biologists and the educated public have lost faith in it. Since the days of Darwin and Wallace, great changes have occurred. The increasing perfection of microscopic technique, the establishment of new schools of biology, the accumulation of more precise data furnished by researches in Palæontology, comparative anatomy and embryology and the formulation of fresh causes of evolution, must be partly responsible for unsettling the confidence of biologists in Darwinism. The evidence from palæontology and

from modern rare species is often contradictory. The Geological record must naturally be imperfect, for the species rare in their own day have not probably left any traces behind them. Moreover, plants do not provide satisfactory evidence of perfectly continuous evolution.

The introductory part of the book gives a frank and faithful account of the present position of Darwinism together with an exposition of the evidences and causes which have been advanced as the result of modern investigations both in its support and refutation. This preliminary survey renders the ground clear for an impartial estimate of the facts. In the subsequent chapters, the following questions are answered: "What is the nature of heritable differences within a species? Are the differences between species of the same or of a different character? Does Selection really occur in Nature? If so, will it account for the formation of species? Must we allow for other causes of evolutionary change?" Finally, after surveying the process of evolution, the author proceeds to ask what judgment we have to make about it. "Is it good or bad, beautiful or ugly, directed or undirected?" Such questions have a philosophical flavour and the answers may not come within the province of science. But the interests of the society are largely concerned with the answers to such questions.

The author occupies a position different from that of speculative and experimental biologists and can write on the subject of natural selection with authority which does not belong to the latter, for he is "One of the three people who know that most about its mathematical theory". Apparently out of consideration for his less mathematical brethren, the mathematical theory of natural selection is treated in the Appendix and printed in small type; but the passion for mathematics is so irrepressible, that in practically every chapter, the reader is treated to mild doses. The second chapter of the book dealing with variation within a species gives an illuminating summary of all the cases of inheritable factors due to Plasmon, Mendelism (single and several genes and their order in a chromosome) and the addition of one or more whole sets of chromosomes. All hereditary differences which have been investigated fall under one or the other of these categories. The new genes themselves arise from time to time by a process called mutation whose importance for any account of evolution is clear. It enables us to escape from the impasse of the pure line. Many of these facts which have been added to our knowledge by experimental biologists were unknown to Darwin. The general conclusion is that interspecific differences are of the same nature as intervarietal. The latter are due to a few genes with relatively large effects and rarely are due to differences involving whole chromosomes. The reverse is true of differences between species. The present position is that we know and can say more about Evolution than was possible in the days of Darwin and further progress in our knowledge depends upon the accumulation of facts concerning variation and selection.

The book is a clear and logical exposition of the possible causes of Evolution, and few can wish for a better book. The outlook is fresh. The use of technical terms is limited, without sacrificing the sense. The thoughts are pregnant and stimulating. The book will always rank as one of the first-rate contributions to the large body of literature on evolutionary biology.

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THE BOOK OF SCIENTIFIC DISCOVERY: HOW SCIENCE HAS AIDED HUMAN WELFARE. By D. M. Turner, with a Foreword by Professor Charles Singer. (George G. Harrap & Co., Ltd., London, Bombay and Sydney, 1933, pp. 259.) Price 7*s*. 6*d*. net.

All human institutions, like organisms, have a life-cycle and their progress and enlightenment at any stage of their history must be a measure of the scientific knowledge attained by their members. Science is part of the structure of the modern society and the achievements of the former are the decorations of the latter. So great are the changes in the daily life of man that he has scarcely time to adjust himself to the new conditions.

The history of the achievements of science and their incessant application to the practical needs of society must be fascinating. Dr. Turner has, in this book, traced the progress of science, in its relations to social change and in relation to human welfare. She tells of Leonardo da Vinci and Galileo, whose work commenced a new epoch in experimental science. Harvey and his work and the age of Newton are reviewed. The introduction of steam power, the industrial revolution, the effect of science on social conditions, the development of the knowledge about electricity, the researches in

medical and social sciences and the steps taken to usher in the modern scientific results are treated fully and clearly.

We can understand the spirit and the outlook of science only when we are acquainted with the evolutionary history of its output. Scientific knowledge cannot get away from traditions. If science has progressed far more rapidly than any other body of knowledge, it is all the more reason for a scientific worker to be acquainted with something of the conditions of its change and development. There are fourteen chapters in the book. Commencing with the characteristics of mediæval thought and the early alchemists, the reader is taken to the different phases of the development of scientific knowledge till in the final chapter he is told of the position that science occupies in our life to-day. A survey of the era of progress has an interest and educative value of its own. The subject-matter is treated in such a way that any chapter can be studied independently of others and yet all the topics when read together fit into one another so as to form a homogeneous unitary picture.

A book of this description is indispensable to students of science. The knowledge that is imparted in the schools and colleges in the name of science is neither inspiring nor interesting. It lacks the historical background so necessary for a proper appreciation of the pioneer work that has preceded. Some of the original drawings of the anatomical preparations of early scientists like Leonardo, Vesalius and Harvey are given as also of the early apparatus used by them. There is liberal education in this book.

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The Romance of Research. By L. V. Redman and A. V. H. Mory. (The Williams and Wilkins Company, Baltimore, in co-operation with the Century of Progress Exposition, pp. x+149) Price $1·00.

The authors have tried to place before the general reader a lucid exposition of the way in which man has acquired mastery over the forces of Nature. A perusal of the book cannot fail to produce in the mind of the public a deep sense of gratitude to those scientists who have by their patient industry and research contributed to the material progress of the society. It is true that there is many a slip between the successful discovery of a principle and the practical application of it to the industries. Perkins was no doubt the first to recognise the potentialities of coal, but it was reserved for the German chemists to extend and exploit his discoveries for the manufacture of the by-products which have profoundly altered the completion of industries. In Beckland we have the case of discovery again of a principle, but it was reserved to him to utilise it for the practical problems.

The book gives a picture of the progress of civilisation through scientific research; and the latter must necessarily include an account of the method, development and achievements of scientific workers. This account is spread over twelve chapters. The greatest lesson which the book sets out to emphasise is that the period of industrial and economic depression is precisely the time when greater investment of money is urgently required to promote fresh scientific research so that the new knowledge might be utilised for establishing new industries and strengthening the old. This lesson like most lessons in life is difficult to absorb. To students of general science, the book furnishes a historical background which will amplify and render clear the knowledge of text-books. They will welcome the book as a useful addition for supplementing their knowledge of scientific methodology. The general reader will find in the book both interest and profit. The progress of science is romantic. It is full of thrills, disappointments and achievements. The contribution of science to the cultivation of intellect is great, but its contribution to the building up of the present-day civilisation is greater. The book records the impressive march of human needs and their supply, hand in hand. To a reflective philosophic mind, the thought "whither are we tending" must naturally occur after the perusal of the book. The book is at once refreshing and stimulating.

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Ocean Waves and Kindred Geophysical Phenomena. By Vaughan Cornish with Additional Notes by Harold Jeffreys. (Cambridge, at the University Press, pp. xv+159.) Price 10*s*. net.

The book represents the fruits of what one may call the labour of love. Dr. Vaughan Cornish went far and wide in quest of his material and he has summarised his observations in these words, "I have never again had a house with such a view as that from my former home on the cliff, but I have compensations in the memory of many wonderful sights of storms at sea; of snow

waves moving in ghostly procession across the Canadian Prairie; of sand waves, rank behind rank, driven by the desert wind; of the onset of the tidal bore in the Severn and the Trent, and of Leaping waves in the Rapids of Niagara." These phenomena are essentially hydrodynamical and therefore part of Physics. For a proper understanding of the subject, the facts collected by Dr. Cornish need to be examined both from the observational and from the mathematical standpoint. No other previous worker has gathered material so extensive and varied as Dr. Cornish has obtained on the subject and in the chapters contributed by him he makes a number of remarks on the theoretical considerations, both quantitative and qualitative. The Additional Notes provided by Dr. Harold Jeffreys of St. John's College, Cambridge, are intended to supplement the work of Dr. Cornish and their interest to navigators, engineers and physicists in general must be obvious.

The first chapter of the book commences with a description of the stormy weather which overtook the ocean in December 1911 and from the promenade deck on board the Liner "Egypt" the author calculated the theoretical wave-length and the speed of the waves and the relation of the latter to the velocity of the wind, from the "period" time interval between successive wave crests, by the application of the well-known formula. He found that when the sea was heaving heavily, the theoretical wave-length for the period of 13·5 seconds, was 931 feet and speed of the swell being 47·25 miles. This chapter discusses how to determine the height of ocean waves from ships on their course, the sea room required for the full development of waves, the steepness of waves on oceans, inland seas and lakes, and concludes with an account of the reaction of ocean swell upon the wind. A practical point affecting meteorological records is indicated as arising from the observations, *viz.*, the direction of the curl on the waves or in other words, their direction of breaking, is in fact the resultant of wave and swell, so that the general run of the waves provides a more reliable index of the direction of the wind. The second and third chapters deal with waves in sand and snow formed and propelled by wind and current, and tidal bores and other progressive waves in rivers.

The book will always be found invaluable to navigators, Royal Marine Engineers, meteorologists and students of Physics. It is eminently readable and the subject-matter is treated in a simple and elegant style. The illustrations are superb. There is a short selected list of original contributions by the author upon waves and allied phenomena.

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GEOGRAPHY OF NORTH AMERICA. By George J. Miller and Almon E. Parkins. (John Wiley & Sons, New York, Inc., Chapman & Hall, Ltd., London, 1934, pp. xviii+621.) Price 28s. net.

We have before us a typical text-book, beautifully illustrated and attractively got up. Every geographical topic is adequately treated and every aspect of human problem is considered from the standpoint of the environmental factors and resources available for promoting its expansion.

The history of the remarkable development of North America since its occupation by the white man must always form an extremely remarkable chapter of the general progress of human civilisation. The commanding position which the wealth of the natural resources of this great continent has given to its people in the international, political and social affairs of the world is likely to become greater in the future, in consequence of the increasing exploitation of the means for its augmentation. The potentialities of North America are almost limitless and the genius of the Americans for their utilisation is also equally great. The whole theme of the book is how the colonisation of America stimulated the natural desires and ambitions of the early occupants and how they made use of the assets of the new country. The outcomes of such endeavours must be naturally reflected in the social, political and economic organisations of the people and the history of these institutions forms an interesting chapter of the book.

The population problem of North America has a peculiar interest. There is the indigenous civilisation super-imposed by a more virile European culture and a large body of imported negroes with the consequential hybrid population. Questions such as the rights and obligations of citizenship and acquisition of property, which must emerge in an acute form sooner or later, have to be foreseen and answered in a manner which would avoid ugly developments. The greatest density of population is in the belt connecting Boston and Pennsylvania through New York—a strip of country where the conditions are highly favourable for man

to make a living through commerce, manufacture and transportation and financial transactions. Since 1930, the population curve is on the horizontal and restriction of growth is due to the general practice of birth-control methods. Whether limited population is a mark of national prosperity is a question which each country must answer, though it is true that the fitness of a continent is best measured by the number of people it can support. Theoretically it is true that the population growth should not exceed the limits of the sustenance power of the country, but have we any reason to think that our improvements have reached a stage beyond which they cannot proceed? The checking of soil erosion, careful selection of seed, the adaptation of crop to soil and climate, the breeding of new varieties of crops, the introduction of new plants, better methods of tillage, the improved methods of the application of manures and fertilisers, the proper and adequate supply of water for irrigation, the improved methods of cattle-rearing, poultry and pig farming and the exploitation of fisheries must provide work, food and habitation for the overflow of population from the industrial and manufacturing centres.

The book is a fine example of what geographical treatises ought to be. Every topic is discussed adequately and critically and every chapter concludes with a set of stimulating questions, problems and exercises. A complete list of reference books for library work is given for the students. Politicians and economists will find in this book as much guidance in national planning as students of Geography will find matter for obtaining a conspectus of the amazingly intricate problems of the North American continent.

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Principles of Human Geography. By Ellsworth Huntington and Sumner W. Crushing. (John Wiley & Sons, New York, Inc., Chapman & Hall, Ltd., London, 1934, pp. xxii + 453.) Price 18*s*. 6*d*. net.

The recent reforms introduced into the methods of teaching geography in the Schools and Colleges necessitate the publication of text-books with a wider outlook on the different principles, and Messrs. Chapman & Hall have produced an excellent series of geographical treatises. We accord them a cordial welcome. The principal feature of these books is that at the end of every chapter, questions, exercises and problems are proposed, which vary in difficulty and in subject-matter, some being physiographic, some economic or historical and many anthropogeographic. The main advantage of such graded exercises is that the teacher and the students have a wide range of choice suited to their ability and interests. Most of the problems are applicable to countries other than those treated in the text-books. The knowledge of the local region, to which the problems are in the first instance to be applied, will furnish the background against the understanding of the remotest parts of the world, will become increasingly clear. The exhaustive list of reference works given in the book will be an inducement both to the teacher and the students to obtain additional information in working out the exercises such as are intended to be solved by the co-operative effort of a group of pupils and the teacher.

The province of human geography is very wide. It includes a description of the appearance, dress, manners, food, pastimes, occupations, dwellings, economic and social organisations, public institutions, government, religion, education and cultural history of the people of the world. They differ widely. It must be an interesting study to discover the causes which have produced wide differences in the civilisation, efficiency and progressiveness of the people. Every one of these problems suggests numerous subsidiary subjects for study and investigation.

The first part of the book dealing with man's relation to physical environment gives an idea of the scope of the enquiry attempted by the authors and is intended to serve as a general introduction to the succeeding parts. As an illustration of the problem in Human Geography the Khirghiz nomads of Central Asia are described in the preliminary section, which is a typical case of "segregation" or "isolation" of a small body of people who have reached a stage of exhaustion of adaptive potentialities and unless they come in contact with the more civilised nations, are bound to become extinct amidst their inhospitable surroundings. The history of these semi-civilised people is an excellent chapter in biology. Whether the influence of the environment is favourable or prejudicial to the growth of new civilisations in isolated territories, must depend both upon the community settling on them and on the natural

resources and assets of the lands. To the Papuans the message of the Niagara Falls must always remain subconscious; the genius of the Scotchman cannot transform the Kalahari desert into an earthly paradise. The efficiency of man in conjunction with good geographical surroundings determines his progress. The decline and extinction of the great historical civilisations are due to the causes which led to the disappearance of the races of gigantic creatures which at one time dominated the earth's surface. Just as the wheels of the railway coaches are tested at important stations, as to their soundness for undertaking the forward journey, so the civilised nations have to pause at important stages of their industrial progress, to test their adaptive potentialities in case of a sudden crash in their artificial environment.

The subject-matter of the book is wide and varied. It is adapted for the use of junior students as well as for the more exacting requirements of senior scholars. Interesting and important problems are prescribed for additional work. Students of Biology and Anthropology will undoubtedly profit by a perusal of the book. No person can follow intelligently the topical events discussed in the daily newspapers, if geographical knowledge does not form part of his mental equipment. Geographical works of this kind must have a great humanising influence, their message extends beyond instructing the intellect.

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TERTIARY FAUNAS: A TEXT-BOOK FOR OILFIELD PALÆONTOLOGISTS AND STUDENTS OF GEOLOGY, VOL. II. THE SEQUENCE OF TERTIARY FAUNAS. By A. Morley Davies. (Messrs. Thomas Murby & Co., 1 Fleet Lane, E.C. 4, London, 1934, pp. vi+235.) Price 15*s*. net.

This book is the outcome of the needs of the students of Oil Technology of the Royal School of Mines for whom the author was required to organise a special course in Palæontology, and it deals with the succession of the Tertiary Faunas in all parts of the world. It is well known that the oil supply of the world is derived from the tertiary formations and a complete knowledge of these rocks and their fossil contents must be an indispensable part of the equipment of the Oilfield Geologist. However, the usefulness of the book is not restricted to oil-prospectors. To the geologists and all students of Palæontology, the book is equally important.

The author's intention was to publish his work on Tertiary faunas in two volumes. The first volume was to deal with the systematic portion of the subject, providing descriptions of all groups forming the assemblage of fossils peculiar to this epoch. The publication of volume I is delayed and the publishers hope to issue it towards the end of the year.

The author in his work on "An Introduction to Palæontology" introduces the students who have to study the subject as a self-contained unit, to the general facts, problems and results of this branch of science. The type-study system followed by this book gives the reader a full account of the common species from which he proceeds to obtain a general idea of the characters and range of variation of the group to which the particular species belongs. A knowledge of the outline of the subject is a necessary condition precedent for the study of Prof. Davies' work on the Sequence of Tertiary Faunas.

Palæontology is generally considered by students duller than even Mathematics. Evoking interest in either of these subjects lies in the mode of handling and presenting its contents. Palæontology in its general aspects dealing with the distribution and migration of animal groups, the conditions under which they flourished or became extinct, the significance of them in relation to the process of evolution and the correlation of geological formations in different regions and the former distribution of land and sea, provides us with a picture of the world that has passed away.

In Europe the upper reaches of the Cretaceous rocks are separated from the Eocene formation by an abrupt gap. The faunas of the latter are strikingly different from the groups occurring in the earlier deposits and the abrupt change is noticeable in the almost complete disappearance of the genera and species characteristic of the Cretaceous period. In India the Tertiary era is not only of interest in respect of the successive faunas, but also in regard to the physical history of the entire sub-continent including the Himalayas. It is usually held that towards the close of the Cretaceous, a large part of the Indian peninsula witnessed a series of eruptions, spreading lava and pyroclastic materials over an area of 200,000 square miles having a maximum thickness

of 10,000 feet. From a study of the petrological and mineral characters of these rocks known as the Deccan Traps which overlie the Bagh beds and Lameta series, their age is regarded as not older than the Cenomanian stage of the Upper Cretaceous, and not much younger than the Danian stage of the topmost Cretaceous. But recently the evidence afforded by the Fossils, tends to show that the Deccan Traps cannot be older than Eocene and it is presumed that they owe their origin to the great earth movements which overtook India at the beginning of the Eocene period which resulted in the breaking up and submergence of the Gondwana continent and the uplift of the sea deposits into the Himalayas.

The book under review devotes very little space to the history of the Tertiary Fauna of India and is almost exclusively occupied with that of the continent of Europe with such references to other land areas as may be necessary to give the students a conspectus of this most interesting epoch of the earth's history. No episode in that history is more dramatic than the rapid evolution in India of a most varied population of the different orders of mammals between the Mid-Miocene and Pliocene, usually known as the Siwalik system. On page 201 of the book, the term "Siwalik Hills" is just mentioned in connection with the Hipparian fauna of the Potian.

As a text-book for oil-field palæontologists, the book serves its purpose admirably and even students of general geology will find it a useful guide in their studies of detailed Palæontology. Within the limits prescribed by the author and the circle of students whom his work is intended to benefit, the book is certainly useful. It will be a welcome addition to general palæontological literature.

Students requiring more detailed information on subjects treated in the book and what is not fully treated, are provided with a complete list of reference works. The usefulness of the book is further enhanced by tables of approximate correlation of the Lower and Upper Tertiary formations and the principal mammalian faunas of Older and Newer Tertiaries. The mass of information contained in the book is its chief value.

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PRINCIPLES OF ANIMAL BIOLOGY. By A. Franklin Shull with the collaboration of George R. Larue and Alexander G. Ruthven. (McGraw Hill Book Company, Inc., New York and London, 1934, pp. xiv+400.) Price 21*s*. net.

The fourth edition of Professor A. F. Shull's book is the outcome of the rapid changes taking place within recent years both in the content and the methods of exposition of Zoology. The subject has acquired a distinct human bias; experimental methods of research are increasingly adopted, and the study of behaviour has assumed a great importance. The changes in the method of approach to the zoological problems are more pronounced in America than in Europe. We have a great body of observational and theoretical facts in the new departments of knowledge such as ecology, genetics, and cytology of which there is an adequate treatment in the book.

The first chapter gives an account of the growth of biological science from the days of the early Greek philosophers, and traces the converging lines of the contributions which have rendered biology seemingly a composite science. The constituent parts overlap and thus give a unitary outlook to the subject. Their methods of study may differ; but all investigations ultimately tend to an elucidation of the phenomena of life and its evolutionary potentialities. A sketch of the life of the great biologists provides the necessary historical and philosophical background so necessary for the cultural value of scientific training. In the third chapter the student is introduced to the study of the elementary chemistry in its relation to Biology and this equipment of knowledge in a sister science is indispensable to an understanding of the operations of the cells. Then we have a series of chapters dealing with the organisation of cells and their constitution in the metazoa, their histology, physiology and reproduction. The chapter on genetics is accompanied by a number of interesting problems, and in the chapter on taxonomy, the requirements of a genetic classification and biogenetic law are briefly discussed. Chapter XVII is devoted to the exposition of ecological problems and the appendix to this chapter gives a synopsis of communities adopted by a Committee of the Ecological Society of America. The succeeding chapters on geographical distribution, fossil animals, modification of species are treated with reference to recent developments in each of these subjects.

The book supplies a distinct want. It is a valuable text-book. No pains have

been spared by the authors in carefully planning the subject-matter and presenting it in an easy and attractive manner. Of the many good features of the book, special mention is to be made of the profuse illustrations, the problems and exercises for further study, a list of reference books, and an explanatory glossary of technical terms. The comprehensive and lucid presentation of the whole subject-matter must be the chief recommendation of the book which we hope will be used in all the Colleges where biology forms part of the University course of studies.

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THE DINOSAURS: A SHORT HISTORY OF A GREAT GROUP OF EXTINCT REPTILES. By W. Swinton. (Thomas Murby & Co., 1 Fleet Lane, E. C. 4, London. 1934, pp. xi+724.)

Generally speaking the history of reptiles is interesting as furnishing evidence of the reptilian ancestry of the higher forms such as the birds and mammals; and that of the Dinosaurs is fascinating as giving us an insight into the enormous size and complexity of these forms which at one time dominated the earth's surface. These terrible animals attained apparently a point of development at which they must have lost elasticity and power of adaptation to the new conditions introduced by the Tertiary era, with the consequence that their entire race became extinct. However, during the period of their maximum development, they had differentiated in a number of ways for the diverse modes of existence and the climatic conditions under which they lived.

The Mesozoic epoch, also known as the Age of Reptiles on account of the preponderance of these animals, witnessed the coming into existence of a bewildering variety of these creatures which dominated every sphere of life. Among the land reptiles of that age those which had adopted a mode of life suitable for existence on trees, in swamps, fertile plains and sandy tracts, are generally included in the group known as dinosaurs. The group is divided into two main orders on the basis of the elements comprising the hip girdle; the *saurischia* including the carnivorous and herbivorous forms and *ornithischia* comprising only plant-eaters. They lived within the period which commencing with the middle Trias ended with the Upper Cretaceous and consequently the diphyletic origin of Dinosaurs is postulated. Among the primitive ancestors from which other reptiles, contemporaneous with Dinosaurs, Ornithischia, Saurischia, pterodactyles, crocodiles and birds seem to have had their origin. The early members of dinosauria possessed a great evolutionary potentiality and this impetus of forward movement manifested in the appearance of the carnivorous (Theropoda), the amphibious (Sauropoda) and the beaked and the armoured forms (Orthopoda). The physical and biological characters of the world in which these reptiles moved and had their being, were far different from the distribution of land and water and the fauna to-day, and these conditions provided them with sufficient supply of food and suitable climate. With the disappearance of these reptiles, the aspect and the contents of the world have changed and have tended to assume the present day characteristics.

The book gives an excellent and complete picture of the origin, the anatomy and the general habits of these extinct Reptiles which both the amateur naturalist and the expert palæontologist will find interesting. It is a valuable addition to our palæontological literature. It is difficult to write a book on what is usually considered as an uninteresting branch of knowledge, which will be read with pleasure and profit and the author deserves congratulations on successfully accomplishing a task seemingly impossible. The illustrations are beautiful and the text figures are clear and helpful in understanding the anatomical features of the animals which form the subject of an indispensable course of palæontological studies. At the end of each chapter is given a complete list of references. In Appendix A is given a list of British dinosaurs only, but as the book attempts to deal with the group as a whole, one might wish for a fuller list of dinosaurs in the schematic form in which the British forms are represented. In Appendix B we have an explanatory glossary of all the scientific and technical terms used in the text, and this must be of invaluable help to all readers who are not familiar with scientific terms. The study of these animals is rendered complete by the inclusion of a chapter on the diseases from which they suffered, the causes which lead to the disappearance of the entire group, their homes, haunts and habits and the zoological and geological importance of their study. The dinosaurs have a message even to the mining and civil engineers whose interests have not been forgotten by the author.

We have read this book with genuine interest and profit and we have every reason to hope that other readers will find both in its perusal. This is one of those scientific works which every man who claims to be cultured must possess and peruse.

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THE ECOLOGY OF ANIMALS. By Charles Elton. (Methuen & Co., Ltd., 36, Essex Street, W. C. London. 1933, pp. 87.) Price 3*s*. 6*d*. net.

The Oxford School of Ecology has popularised the subject and its influence is great. Sooner or later it is bound to form part of the systematic course of biology and together with the study of the behaviour of organisms, the two branches of knowledge, it is hoped, will impart a new outlook and significance to the teaching of general Zoology. The ecological study refers to the relation of the organisms to the environment, the inter-relations of animals, their population, general habits, migration, food and enemies and there are three methods of approach, *viz.*, field observation, experimentation, and nomenclature. The points of contact which ecology makes with other subjects are taxonomy, morphology and comparative anatomy. The study of animal behaviour, on the other hand, leads to comparative psychology and the action of physical limiting factors requiring a knowledge of physiology.

The British and American Ecological Societies have organised surveys and have defined communities. They were primarily undertaken in connection with agricultural research. The importance of plant and animal organisms in relation to soil fertility is a matter of common knowledge which has been greatly systematised and enlarged by ecological researches. From the point of view of developing marine forest and other resources, comprehensive ecological surveys have still to be organised and there are gaps in our knowledge of the number and variety of animals in grass moors, hedgerows, swamps, sand-dunes, ponds and hill streams, still to be bridged. There are other economic problems which fall within the province of ecological investigations, such as the diseases of man; those relating to useful land produce, fisheries including whale fisheries; conservation of useful mammals and birds. Apart from the interest which such studies have on the general health and well-being of man and the expansion and prosperity of his industrial organisations, the future of ecology as the accurate study of natural history is bound up with the planning of educational courses for rural and urban schools.

This little manual provides the reader with a general knowledge of the scope of this interesting branch of natural history in all its aspects. The book is a good addition to biological literature and students in schools and colleges studying biology will find it an excellent manual. Its usefulness to the practical agriculturists, to students of medicine and forestry is equally great. There is a selected list of reference works to which readers wishing for more detailed information than is provided in the book itself, may refer. The book maintains the high traditions of the Methuen Biological Series.

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NATURE STUDY READERS: TEACHERS' SCHEME BOOK FOR FIRST AND SECOND YEAR PUPILS. By Phyllis S. Darling, M.R.S.T., F.R.G.S. (Oxford University Press, Bombay, Calcutta and Madras, 1934, pp. 55.) Price As. 8. And
NATURE STUDY READER FOR SECOND YEAR PUPILS. By Phyllis S. Darling, M.R.S.T., F.R.G.S., with Decorations by Mina Buchanan. (Oxford University Press, Bombay, Calcutta and Madras, 1934, pp. 11.) Price As. 4.

These two little books do a great credit to the enthusiasm and sincerity of the author.

> "The aim of this series is to help pupils and teachers, too, to collect evidence by being always watchful and ready to seize every opportunity that comes to them, then to try and draw conclusions by examining and classifying the material they have collected, and finally to test their own conclusions, by comparison with those of others and by further investigation."

Stated in a less eloquent way, the object of the book is to open the eyes of the pupils to the variety and beauty of animal and plant life in their surroundings so as to lead them to take an intelligent interest in the habits and interrelations and life histories of animals easy to be kept under prolonged observation. Children take a great interest in making collections, in sorting them out and naming them. This instinct is the basis of all future education, the success of which depends upon its early cultivation.

In the Indian schools, there is a dull uniformity of courses and the little interest and curiosity which the children may bring with them are practically killed either by the ignorance of the teacher or by the stupid

curriculum. If the educationist were to succeed in introducing nature study as part of instruction, it is forthwith taught from a book in schools situated in the busiest streets of a populous town. Education in Indian primary schools is deplorable. How the children survive this torment, is a mystery. A large number succumb annually. Education yields its best results when it is imbibed unconsciously. Have we provided for it? These little books point to the way how to do it.

The lessons for the first and second year are carefully chosen and the pupils are given plenty of interesting exercises which they would love to do. These books are intended to provide guidance to the teacher and the author has been careful not to give details lest they should be dictated to the pupils. If the instructions of the book are faithfully carried out, we have no doubt that the children's powers of observation, their manipulative skill and desire to learn first hand are bound to improve.

We congratulate the author on the extreme care and sympathy with which she has written the books for the use of the little pupils who, we have no doubt, will greatly profit if the teachers in charge of them know enough of the subject-matter to handle it intelligently. We would like to see further publications of the series for the higher classes.

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THE ELECTRONIC THEORY OF CHEMISTRY. By R. F. Hunter. (Edward Arnold & Co.) Price 8*s*. 6*d*.

The Electronic Theory of Valency, a logical development of thought and experiment in the field of theoretical and experimental physics and chemistry, has now advanced to such a stage that no serious student can afford to neglect its study. The synthesis of urea is considered to be the birth of synthetic organic chemistry, and in a sense the conversion of ammonium cyanate into urea is a tautomeric change. In spite of the fact that tautomerism was known for over a hundred years and many examples are crowded in all books dealing with organic chemistry, no intelligent explanation of the phenomenon was possible till the Electronic Conception of Valency was applied to organic reactions by the British School of Chemists.

The theory of aromatic substitution has been a difficult side of organic chemistry till Lapworth, Robinson, Ingold and their collaborators placed it on the sure footing of electronic conception. The conception of the sextapule (closed group) theory of benzene constitution, developed by Robinson and Ingold, and applied by Robinson to explain the "aromatic type", has been the subject of a brilliant analysis by Hükel. The classification of reagents into different groups by Lapworth and Robinson, and Robinson's experimental substantiation of a series of organic reactions have effectively settled many vague and profitless speculations.

The stability of free hydrocarbon radicals was first tackled by Ingold who introduced the conception of ionic dissociation of hexaphenylethane molecule. Recently Pauling and Wheland have applied the quantum mechanical method of calculation of resonance energy to free hydrocarbon radicals, and their results lend great support to Ingold's theory.

Sidgwick's theory of co-ordination is one of the greatest achievements of modern inorganic chemistry. The explanation of the ammonium-ion formation by the co-ordination of a proton is the only intelligent explanation available. The structure of the isocyanide group and carbon monoxide on the basis of semipolar double bond have received considerable support from the study of Raman spectra. The work of Heisenberg, Dirac and others have resulted in the conception of the single electron linkage, and its applicability for elucidating the structure of many compounds has been fully demonstrated.

The book under review is a very admirable treatise of the subject and is certainly an acquisition to chemical literature. It is conveniently divided into twelve chapters and these, taken either individually or collectively, are difficult to be improved upon, considering they are the subject-matter of a series of lectures, normally of an hour's duration. A highly satisfactory author index and subject index, and the important references given at the end of each chapter add to the usefulness of the publication. I would, without the least hesitation, recommend to each and every student of chemistry to possess a copy of Prof. Hunter's contribution to the study of modern organic and inorganic chemistry.

K. N. MENON.